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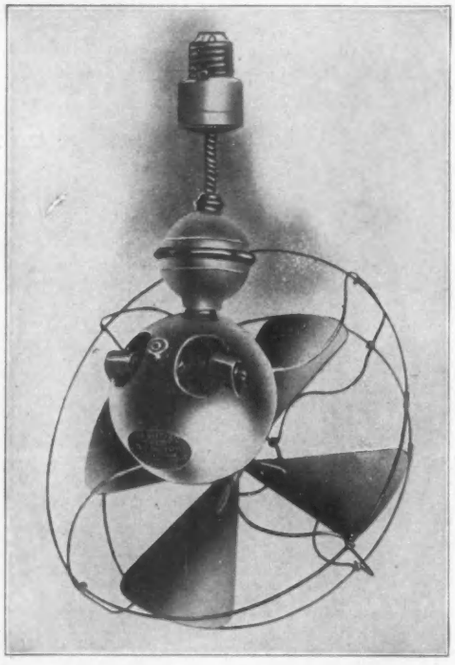

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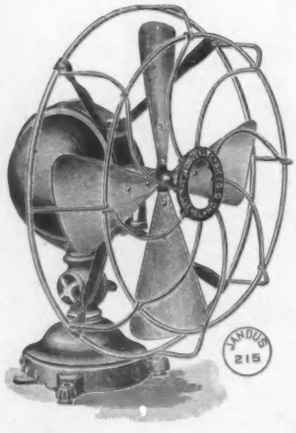

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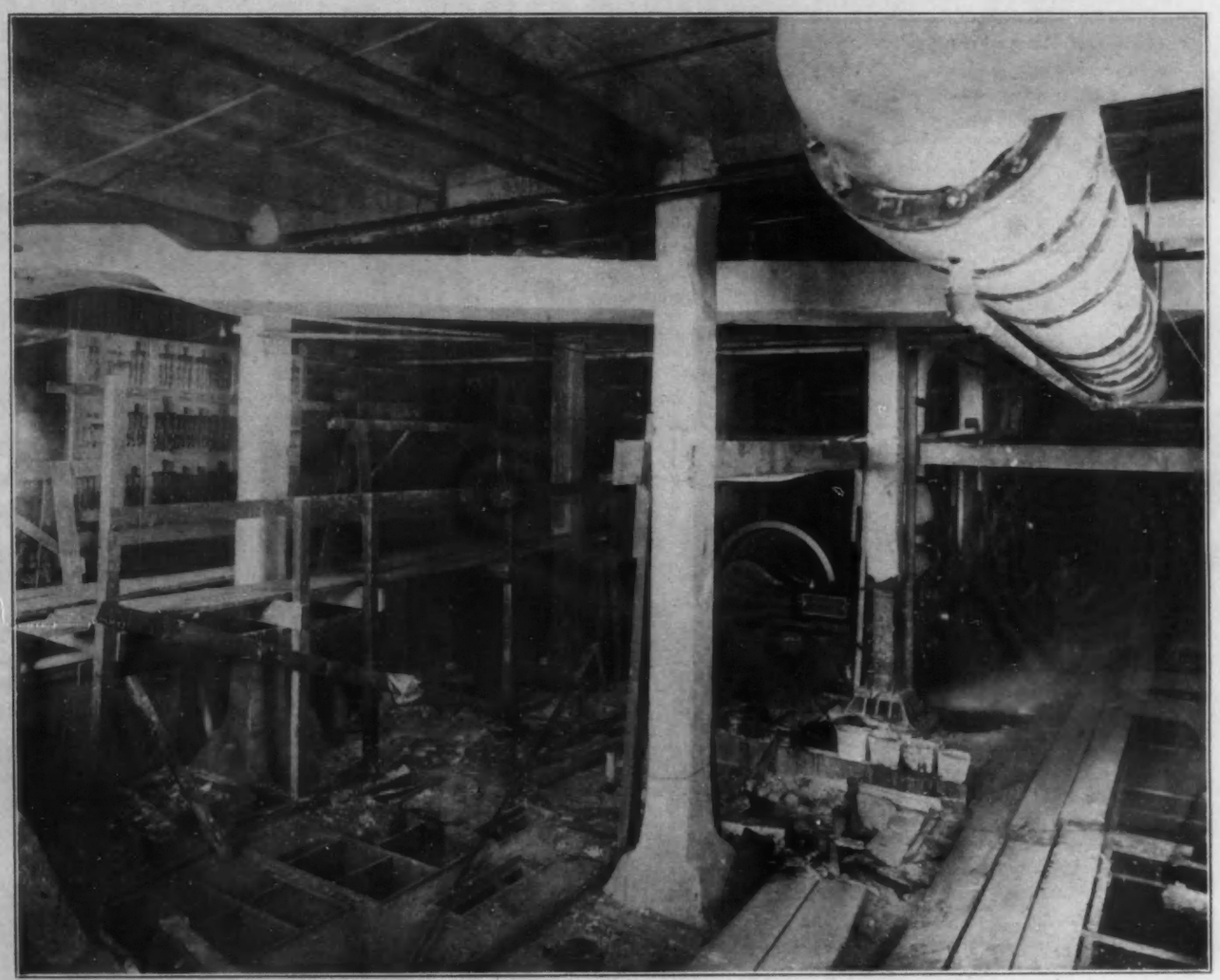
The Engineers' Architects' and Builders' News

VOLUME XVIII. SAN FRANCISCO, CAL., MAY 18, 1907 No. 20

ELECTRIC INSTALLATION OF THE HOTEL FAIRMONT

Wishing to be independent of any possible break-down in the power plants supplying current for San Francisco's use, the Fairmont Hotel management has installed a generating plant capable of supplying all the lights and motors in the building. As shown in the accompanying illustration, this plant is but half completed, and until the installation is finished considerable current will be taken from the wires of the California Gas & Electric Corporation.



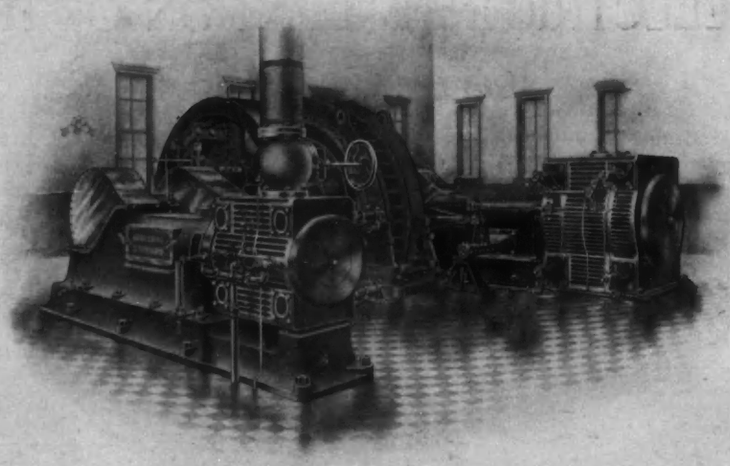
GENERATING PLANT OF THE HOTEL FAIRMONT

The dynamos are two in number, both being direct-current, three-wire Westinghouse design, one generating 75 kilowatts, the other 150 kilowatts. The former is direct connected to a 11x16x12 tandem compound Ideal engine, running at 275 revolutions per minute. The latter is likewise direct connected to a 17x16x12 Fleming four-valve engine, running at 215 revolutions per minute. The engines were furnished by Chas. C. Moore & Co., Engineers, of San Francisco. Similar engines are to be placed in the pits shown in the picture. Here, as throughout the rest of the plant, all machinery is firmly mounted on concrete foundations.

The 3-wire system saves considerable copper, giving economy in distribution. The 220-volt motors are supplied from the smaller machine, while the lamps are supplied from the 300-ampere generator. Both furnish current at 250 volts. By this system 110-volt lamps and motors may be symmetrically connected approximately half and half between the neutral and each outside lead, 220-volt constant speed motors across the outside lines, 220-volt variable speed motors across the outside lines, and their low voltage con-

nections divided between the two sides of the system. But a small proportion of the current is delivered over the neutral wire and the greater part of the total energy is transmitted at the higher potential. Westinghouse 3-wire or double voltage machines differ from standard single voltage, direct current machines only in that additional leads from the armature winding are connected to collector rings mounted on the armature shaft.

Steam is to be furnished from six Parker boilers, furnished by the Keystone Boiler Works, of San Francisco. The present boiler set comprises two Parker and two Franklin boilers. The restriction in vertical height required that the lower fire boxes of the boilers be cut off, and also necessitated using horizontal tube boilers in order to get the requisite 2,000 square feet of heating surface. Chief Engineer Leavitt introduced an oil-burning system of his own planning, designed especially for long fires in low settings. All pipes and radiating surfaces are covered with magnesia blocks.



FLEMING FOUR VALVE CORLISS ENGINE

The building is piped throughout for both lighting and telephone service with iron armor conduit. Each room has its own telephone connection through the main office, and this branch of the work is noteworthy from the fact of its being the largest private exchange on the Coast, over 1200 drops being controlled, and operated from the main office board.

The lights in the various rooms are individually controlled from flush switches and each floor from the second up to the seventh has four centers of distribution, equipped with tablet boards with separate control for each circuit ramifying therefrom.

These boards are three-wire front-connected tablets, with two-wire distribution, the bus-bars being mounted on the face of the tablet, and all switches being protected with National Code Standard cartridge fuses.

All metal work is highly polished, and mounted on marbleized slate, with lining, and a wiring compartment of three inches is provided all around to permit of easy access, and arrangement in connecting up, as well as in the event of any trouble. The outside compartment is a metal box into which all circuits are brought with iron armor conduit, the finish being separate and of the same material as the surrounding woodwork, held in place by four screws, making it possible to quickly and easily gain access to the wiring compartment in case of necessity. The appearance of these boards as a whole presents an extremely pretty effect, especially so the one located in the main lobby. This board is made of white Italian marble with highly polished face, and has 88 D. P. panel switches with fuses, and is arranged as a double panel, having two sets of bus bars, all highly polished and mounted on the face of the board.

Each distribution center has a separate set of feeds which run direct to the main board located in the engine room.

The fixtures in the various public rooms are the finest ever seen on the Coast, and various effects, produced with due regard to the surroundings, are in such perfect harmony as to excite the admiration of any lover of art. The effects in vines and trellises as well as other emblematic objects, are entirely original, and are the design of Mr. G. A. Shastey, the supervising agent.

The main controlling panels are located in the engine room, and comprise a continuous board 32 feet 8 inches long.

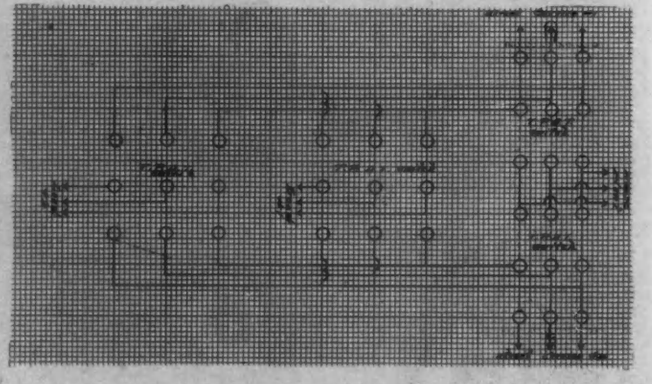
These panels are of two-inch blue Vermont marble, 70 inches high, and the arrangement of the various controlling switches is made with the object of convenience and system, and it is almost impossible to cause trouble, the board being practically fool proof.

The first four panels to the left control all the lighting feeds and comprise thirty-one 100-ampere, two 200-ampere, two 300-ampere triple pole National Code fused switches. The lighting load is split into halves, and a double set of three-wire bus bars feed these panels.

Next to these panels is the break down panel. This has four 1,500-ampere ammeters, at the top, so connected that the load on either set of bars is always indicated.

There are two 1,500 ampere T. H. triple pole double throw and two 1,000 ampere triple pole double throw switches for the main lighting control.

The following cut shows the connections of these switches. Following the lighting breakdown panel, come the four generator panels for the control of one 75-kilowatt, two 150-kilowatt, and one 200-kilowatt three-wire Westinghouse generators.



WIRING CONNECTION

These are arranged to run in multiple on either power or light bars, so it is possible to run only one machine on power and the balance on lights, or in fact, any combination desired.

Following this comes the power breakdown panel for the control of all power circuits. A 1,000-ampere ammeter registers this load at all times, irrespective of whether service is from house plant or city.

One 1,000-ampere D. P. D. T. and one 500-ampere D. P. D. T. connected to various services, allow either the power side plant or light side of the house plant, or the street

service to furnish the power bars. A recording wattmeter is connected direct to power busses.

The last panel is the power controlling panel, and comprises eight 75 amperes and four 200 amperes D. P. S. T. National Code fused switches.

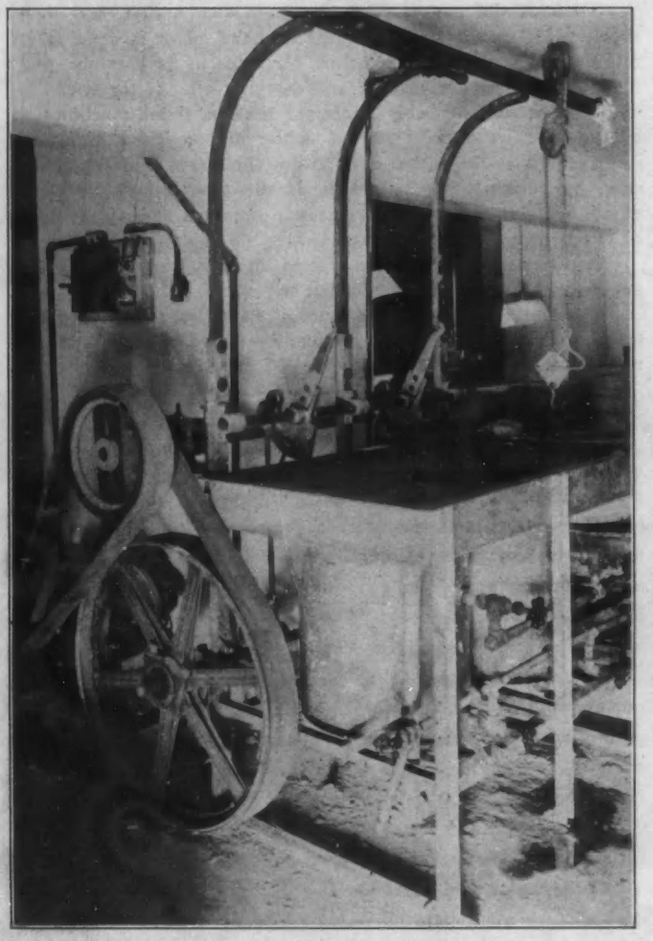
All switches on the board are hand finished, of German scroll design, and all screws and nuts are highly polished, and gold lacquered.

It might be mentioned in connection herewith that the entire installation of switch and panel boards, comprising a total of 1012 circuits, and the main board, was not let until the 12th day of March, and that the building was lit and ready on the 16th day of April.

This work, comprising as it does the largest job of its kind ever done in this city, was carried to a successful completion by the Drendell Electrical and Manufacturing Co., all of the material for the same having come from their own stock, this being proof of the fact that this company is in a position to handle practically any installation regardless of the magnitude or conditions to be met.

The source of supply from the street service for the lighting is furnished by a two-phase high tension primary line of 2,200 volts.

This is connected as a single phase three-wire secondary system, so arranged that either bank of transformers can, in case of emergency, supply the entire lighting load of the building, as will be noted by connections as shown on the lighting breakdown panel, cut of which is shown above.



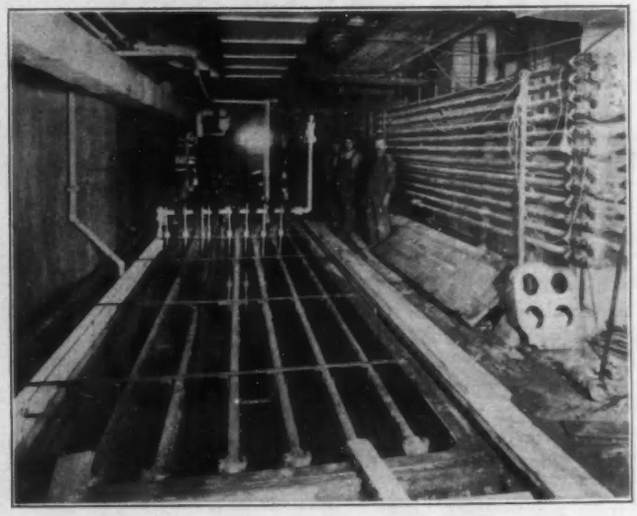
DISH WASHING MACHINE

The probabilities of any contingencies arising that would necessitate a complete shut down, under this system of control, are so remote that it seems almost an impossibility.

The completion of the work now in progress is under the direction of Mr. L. R. Boynton, formerly superintendent of construction for the Hendy Electric Co.

The various applications of electric current throughout the hotel are not only interesting but also illustrative of the importance of the electric motor in the domestic economy of to-day. Thus, in the kitchen all dish washing is automatically done by two New Century dish-washing machines belted to motors. The accompanying picture shows the device for washing the knives, forks and spoons. The copper pot with perforated bottom is filled with the silverware, and, by means of a chain block, is raised from the table and lowered into a larger pan filled with suds, being supported by an arm which imparts a vertical motion to the cylinder by means of shaft and eccentrics. Steam is used for heating. The crockery machine consists of three cylinders. An electric motor is used to run the ice-cream freezers. As originally planned, the equipment of the kitchen was to include various electric cooking devices. But, as the Palace Hotel management brought a large steam-cooking plant from their temporary "Little Palace," the matter of installing the electric devices has been postponed.

The laundry equipment is all electric driven. It is in two sections; one for the plain, unstarched goods of the hotel, the other for the guests' clothes. The latter has not been completed yet. The soiled clothes are placed in three cylindrical rotary washers driven by a 7½-horsepower motor, which is capable of driving three more washers, yet to be installed. The two extractors are each direct-connected to 3-horsepower motors. The water is removed from the clothes by the centrifugal force derived from 1,000 revolutions per minute. From these the clothes are taken to a rotary loosener which prepares them for the mangle. This is direct connected to a 3-horsepower motor that gives from fifteen to twenty per cent. efficiency over and above a steam-driven machine. The latest designs of drying and ironing devices have been installed. Drying is to be done by a Bonds & Erbe conveyor dry room, capable of drying shirts, collars, cuffs and starched articles in twenty-five minutes. All ironing is to be done by machines, working automatically and independent of skilled operators. All machines are to be run by a 10-horsepower motor. The laundry equipment was put in by the Western Laundry Co., of San Francisco.



REFRIGERATOR PLANT

The refrigerating and ice-making plant is very complete and covers a large field in its duties. The accompanying view shows it in course of construction. The system used is known as the ammonia compression system, using brine as a circulating medium. The brine is cooled in a large steel tank by the evaporation of ammonia in coils submerged in the brine. The ammonia gas from the evaporation is exhausted from the coils by a double-acting, horizontal,

ammonia compressor. This compresses the gas to the liquifying pressure and forces it into a double pipe condenser, where it is condensed or liquified and is ready to be used in the evaporating or expansion coils again. The process is continuous and little or no waste of ammonia is caused.

Ammonia storage tank, the oil separator, and the scale traps with their attendant connections go to make up the complete ammonia system.

The compressor is rated at a 25-ton refrigerating capacity, which means that it will perform the work equal to the melting of twenty-five tons of ice every twenty-four hours. The compressor is driven by a Corliss steam engine directly connected to crank shaft.

The brine cooled as before mentioned is used for the twofold purpose of circulating through coils placed in the various cold storage rooms and boxes situated in convenient localities in the culinary and storeroom departments, and also for freezing ice.

There are over twenty different cold-storage rooms or boxes. Each room is provided with separate circulation and regulation. These include the general supply or storage rooms in which the supply of the various perishable materials are kept, and also the supply of wines and beers. The service boxes, from which the materials are delivered, as called for by the patrons, are placed throughout the various departments of the kitchen in which the food is prepared. Consequently the food passes directly from cold storage to the fire or to the dining room, as the case may be.

Great care has been taken with the insulation of the cold-storage rooms, the walls, floors and ceilings being constructed with air spaces and four inches of sheet cork. No wood is used for the interior construction, the walls being plastered with special waterproof plaster. Galvanized iron is used for shelving. This makes a germ-proof and thoroughly clean and sweet room.

The brine mains leading to and from the various rooms contain about 1000 feet of pipe, and are insulated against heat by sectional cork coverings two inches thick.

Five tons of distilled water ice can be frozen daily in the brine tank, which has been placed in the machinery room. The ice is frozen in 100-lb. cakes for convenience in handling and is stored for distribution in a refrigerated room adjoining the ice tank. Electric-driven power machinery has been installed for cutting ice into cubes for drinking water, and shaving and crushing ice for various purposes.

To insure the purity of the ice an elaborate distilling and purifying apparatus has been put in, which works as follows: Exhaust steam is automatically supplied from the engine as needed and is run through an oil separator or filter, thence to a steam condenser of the marine surface type, and from there the condensed water runs to the reboiler, where it is thoroughly boiled and a portion allowed to skim or overflow. The reboiler removes air and other gases. From there the water is pumped through a water cooler, in which the hot water is cooled to the normal temperature by a circulation of cold water. From the water cooler the water passes through a charcoal filter which acodenizers and cleans it. From the filter it passes to a storage tank in which is placed an ammonia cooling coil. This coil cools the water to thirty-five or forty degrees, and it is ready to be filled into the cans. On its way to the cans it passes through a final sponge filter. The filling of cans is automatically regulated and a traveling crane is provided for raising the cans from the freezing tank.

The plant was furnished and installed by the Vulcan Iron Works of this city under the direction of Mr. J. T. Ludlow.

The heating and ventilating plant is electric-driven, and is so arranged with force and exhaust fans as to be controlled entirely by one man. The private dining rooms, basement, mezzanine, dining hall and ballroom are supplied by a steel-blade blower from the American Blower Co., of Detroit, Mich., and, like all the other blowers, is direct connected to an electric motor. Other fans were supplied by Wm. Bayley & Sons, of Milwaukee. All fans are encased in sheet iron, originally furnished by the Globe Sheet Metal Works, of San Francisco. During cold weather the air will be heated before being sent to the various parts of the hotel. All fumes are drawn from the kitchens and laundries by exhaust fans.

STARTING A MOTOR.

Before attempting to start a motor for the first time, test out the field circuit to see that it is closed. This may be accomplished as follows: Remove the wire at the starting box from the terminal marked "Arm," and carefully insulate the end. Then close the main switch and bring the starting lever up to the running position, and note whether the release magnet holds the lever in position. This shows whether or not the circuit is complete, since the magnet is in series with the field. Leaving the starting box in the above position, go to the motor and, with pliers or a piece of iron, note whether the poles give a magnetic pull. In performing this operation be very careful not to touch the field terminal, thus grounding or short-circuiting the field. As a final or third test, slowly open the main switch, and if an arc results the field circuit is complete. These tests should always be made before attempting to start up a motor for the first time.

When these tests have been completed, see that the main switch is open and the starting lever at the off position, thus opening the circuit; then replace the armature lead in its terminal on the starting box.

To start the motor, close the main switch first, and then slowly bring up the starting lever, until the motor is running at full speed. See that the armature oscillates in its bearings, and that all oil rings are turning and carrying oil. If the speed is excessive it will probably be found that in shunt machines a field coil is wrongly connected, while in compound machines it may be that the series is opposing the shunt. In the latter case, by reversing the series leads the trouble will be remedied, but generally it will be best to secure a competent man to check over the connections.

A series motor should be started up with load, never without load; if started without load it will race.

See that the starting resistance is in series with the armature; on starting cut it out gradually.—Allis-Chalmers Instruction Book.

METHODS OF WATER PURIFICATION.

For the removal of solids in suspension, gravity or mechanical filtration is generally employed and the present tendency is toward the increased use of those mechanical filters that combine the maximum of filtering area with the minimum of floor space required. These conditions are found ideally represented in the filter press, which, when used for water, has a large capacity.

Waters containing salts in solution can often be partially purified by boiling, but this is much more costly than the precipitation of the salts with chemical reagents. If, however, chemical materials alone are employed, they must either be used simultaneously with other processes or sufficient time allowed for the subsidence of the flocculent matter precipitated by the treatment.

Either of these methods has its disadvantages, and in consequence an apparatus is generally used which will both assist the chemical reaction required and also remove the impurities thrown out of solution.

These apparatus, which are of various designs, are called water softeners, and are the only true solution for the difficulties arising from the use of bad water.

THE USE OF ALUMINUM AS AN ELECTRICAL CONDUCTOR.

By H. W. Buck.

About the year 1898, the price of aluminum had been so reduced by the commercial application of the Hall process, that this metal began to come into prominence as a competitor of copper for use as an electrical conductor. In physical characteristics, aluminum differs materially from copper. Its properties give it some advantages, and some disadvantages. Some of its physical constants as it is now manufactured commercially for electrical purposes are as follows: Melting point, 1157 degrees Fahr.; elastic limit, 14,000 pounds per square inch; ultimate strength, 26,000 pounds per square inch; modulus of elasticity, 9,000,000; electrical conductivity, 62 per cent.; specific gravity, 2.68; co-efficient of linear expansion, .000,012,8.

On account of its properties, aluminum is not applicable to all the purposes for which copper is used electrically. At present its electrical utility is confined to (a) bus-bars, (b) high-tension overhead uninsulated conductors, (c) low-voltage feeders, usually insulated with weatherproof braid only.

Aluminum is barred from use in a number of cases on account of the practical impossibility of applying the ordinary methods of soldering. Its surface seems to have a coating of oxide on it at all times, which prevents the adhesion of the soldering metal.

At the present relative cost of the two metals, aluminum is about ten per cent. or fifteen per cent. cheaper than copper of the same resistance. The weight of a unit length of aluminum wire is only forty-seven per cent. of a copper wire of the same length and resistance. Consequently

$$\text{aluminum can cost } \frac{1.0}{0.47} = 2.13 \text{ times as much as copper per}$$

pound and still cost the same as copper per unit length from the standpoint of electrical resistance. As a matter of fact, however, the price of aluminum at present is less than 2.13 times that of copper per pound, so that it is actually cheaper to use aluminum as an electrical conductor than copper, where other considerations do not enter.

Use for Insulated Cable.

For all forms of wire and cable which have to be insulated with expensive materials, such as rubber, aluminum is at a decided disadvantage. Its lower conductivity necessitates a greater diameter than a copper conductor of the same resistance, and the extra cost of insulation required to cover the aluminum prevents it from competing with copper for this particular purpose on the basis of the present relative costs of the two metals.

Interior Wiring.

The difficulty in soldering aluminum wire conveniently, and the greater cost of covering it with insulation, renders its use for interior wiring practically out of the question.

Telephone Wires.

The high co-efficient of expansion of aluminum wire, and its comparatively low tensile strength, causes a greater sag at high temperatures than with copper in overhead line work. In telephone construction, where the wires, by necessity, are strung close together on the crossarms, this greater sag of aluminum would probably result in contact between wires at the deflections which would occur at summer temperatures. For this reason, together with the soldering difficulty, where lateral connections are made, aluminum is practically shut out of competition with copper for this particular use. There is also some objection to the use of aluminum wire as small as that required for telephone purposes, on account of the necessity of stranding it. There is no reason, however, why aluminum should not be used as a conductor for isolated aerial telephone lines, if a large enough wire can be used. In cases known to the writer where it has been used for such telephone circuits, it seems to have operated as a particularly good carrier of the voice. This may possibly be due to the particular balance which exists in an aluminum wire between resistance, inductance and capacity, aluminum having somewhat less self-induction, and more capacity, than a copper wire of the same resistance.

Bus-Bars.

Aluminum is particularly well suited for bus-bar constructions. Here no insulation is usually required over the bus-bar metal, while the great saving in weight, and the lower cost, are decided advantages in favor of aluminum. Care should be taken, however, in using aluminum for such purposes, to provide for expansion and contraction with changes in temperature, which is greater in aluminum than in copper. The increased section of an aluminum bar over a copper bar of the same resistance, affords greater radiating surface and allows a given current to be carried with a lower rise in temperature. Consequently, for a given temperature rise, which is usually the limitation in a bus-bar installation, and not "drop," an aluminum bar will weigh only about 38 per cent. of a copper bar for the same heating. This is an obvious advantage for aluminum. Such bars are being used extensively for carrying currents of very large volume, such as are required in low-voltage electrolytic plants.

Low-Voltage Feeders.

A very wide application of aluminum has developed for low-voltage direct-current feeders, especially for railway work. Sizes up to 2,000,000 cm. are in use for railway feeders, the cables being usually covered with weatherproof braid. Aluminum has many especial advantages for this purpose. The quality of the poles and crossarms frequently installed for the support of railway feeders is not of the best, and the 53 per cent. reduction in weight in the use of aluminum saves in maintenance and in line break-downs. The cost again enters as a 10 per cent. or 15 per cent. advantage. Furthermore, the increased radiating surface of the aluminum feeder allows a greater overload to be carried by it than with copper, without melting out the compound of the weatherproof braid, which happens so frequently in copper feeders from overheating, when cars become bunched on the line.

High-Voltage Overhead Lines.

The most prominent use of aluminum, electrically, and the one over which there has been the greatest amount of discussion, is that for overhead high-voltage transmission circuits. When aluminum was first introduced for overhead conductors, it was furnished in the solid form. Considerable trouble was experienced with this kind of wire from breakage resulting from flaws in the metal, and from "crystallizing" of the wire from swaying in the wind. About the year 1900, the stranded form was substituted for even the smallest sizes (No. 4 B. & S.), and the original trouble from breakage has been entirely eliminated.

The writer has communicated with most of the principal users of aluminum wire in this country, in order to establish, by the expression of opinion of prominent engineers, the position of aluminum as an overhead conductor in comparison with copper. The replies to these inquiries have brought out the following points:

1. That the experimental stage in the manufacture of aluminum wire has passed, and that the product, as now furnished by its manufacturers, is entirely reliable, and up to the guarantees made for it.

2. That there is no appreciable disintegration of aluminum wire from ordinary atmospheric conditions. Certain special cases have been reported of corrosion, all of them

affecting short lengths of wire only. One where wires were subjected to chemical fumes from factories, and others where the wire was exposed continuously to salt fog on the Pacific coast. It is probable that any metal would have been affected by this action. Under usual conditions, however, even on the sea-coast, aluminum is a durable metal. Weather-proof insulation serves as an effective protection against corrosive influences, when not accompanied by continuous moisture which will keep the weather-proof braid saturated. The Niagara Falls Power Company has successfully protected its aluminum line with weather-proof braid where it passes through the chemical factory district. On the sea-coast, where the atmosphere is damp, aluminum should not have weather-proof covering, for the above reason. The metal will protect itself by thin impervious coating of oxide, which is better than any artificial covering.

3. That no trouble is being experienced with the stranded aluminum wire in breaking from flaws, "crystallizing," etc.

4. That aluminum wire gathers much less sleet than copper. This is perhaps due to the grease which is absorbed in the aluminum due to its porous qualities, in the process of wire drawing or from some other physical condition of its surface.

5. That it costs less to string aluminum wire on account of its lighter weight.

6. That care must be taken in stringing aluminum wire in rough country on account of its softness; stones or rough places on the ground causing considerable abrasion, where the wire is dragged along the ground.

7. That the mechanical and splice joints as now used on aluminum wire are entirely satisfactory without the use of solder.

8. Care should be taken in the design of an aluminum pole line to place the wires as far apart as possible, in order to avoid trouble from burning off of the wire in case of a short circuit. The melting point of aluminum is much lower than that of copper, and the damage from a prolonged arc is therefore greater. If the wires are placed sufficiently far apart, any arc which may be formed will be so unstable that it will travel rapidly with the wind, or by magnetic repulsion, and will not stay long enough in any one spot to cause any appreciable burning.

The fundamental consideration which enters into the use of aluminum for overhead line work is that of wind pressure, and especially so in modern long-span construction problems. Aluminum is at a disadvantage compared with copper in this matter of deflection where long spans are considered. For example, supports for 400-foot spans of aluminum of 265,000 cm. section will have to be 3.4 feet higher than the supports for equivalent copper. For spans of 300 feet or less the matter of deflection is unimportant, for it makes little difference whether the deflection is two feet or three feet, more or less. But in very long spans where the difference may be 20 feet in the case of copper and 30 feet in aluminum, the question of deflection is of considerable moment, and the advantages are in favor of copper. The height, therefore, of a support for a long-span line of aluminum would have to be greater than for a copper line. Its strength, however, need not be so great as would be required for the support of a copper span. The weight of the aluminum wire is only 47 per cent of the copper span of the same resistance, and, furthermore, the tension in the aluminum cables will be from one-half to one-third those of the copper ones, depending upon the temperature. Where there are bends in a line, and when each pole is designed to withstand unbalanced strains due to the breaking of one or more wires, the lesser weight and tension on the aluminum cables is a decided advantage which offsets, in a measure, the increased height required for the aluminum supports.

No account of the extra weight, due to the formation of sleet on the wire, is taken in the calculations in this paper, for it does not seem to be the experience of most engineers that sleet forms on high-voltage wires. This is, perhaps,

TABLE I.—Dimensions and Resistances of Aluminum Cable. Resistance at 75 Degrees F. Resistance per Mil-Foot, 62 Per Cent Conductivity=16.949 Ohms.

SIZE.	Diameter stranded inches.	Area square inch.	Pounds per 1000 feet feet	Pounds per mile.	Feet per pound.	Ohms per 1000 feet.	Ohms per mile.	Elastic limit, spunod	Ultimate strength, pounds.
1,000,000 CM	1.15	.7870	920	4,858	1.087	.01695	.08950	10,995	20,420
950,000 CM	1.12	.7470	874	4,617	1.144	.01784	.09420	10,440	19,400
900,000 CM	1.09	.7075	828	4,374	1.208	.01883	.09942	9,900	18,380
850,000 CM	1.06	.6680	782	4,131	1.279	.01994	.10529	9,350	17,360
800,000 CM	1.03	.6290	736	3,888	1.359	.02119	.11188	8,800	16,340
750,000 CM	1.00	.5890	690	3,645	1.449	.02260	.11933	8,230	15,320
700,000 CM	.96	.5500	644	3,402	1.553	.02421	.12782	7,700	14,300
650,000 CM	.93	.5120	598	3,159	1.672	.02608	.13770	7,150	13,270
600,000 CM	.89	.4720	552	2,916	1.812	.02825	.14917	6,600	12,250
550,000 CM	.85	.4330	506	2,673	1.977	.03082	.16275	6,050	11,230
500,000 CM	.81	.3930	460	2,430	2.041	.03300	.17900	5,500	10,210
450,000 CM	.77	.3540	414	2,187	2.415	.03766	.19884	4,950	9,190
400,000 CM	.73	.3141	368	1,944	2.718	.04237	.22370	4,400	8,170
350,000 CM	.68	.2750	322	1,701	3.106	.04843	.25570	3,850	7,150
300,000 CM	.63	.2360	276	1,458	3.623	.05652	.29830	3,300	6,130
250,000 CM	.58	.1965	230	1,215	4.348	.06780	.35800	2,750	5,110
0000 B & S	.54	.1661	194.7	1,028	5.733	.08010	.42290	2,330	4,320
000 B & S	.47	.1317	154.4	816	6.477	.10100	.53315	1,850	3,430
00 B & S	.42	.1045	122.4	647	8.165	.12740	.67270	1,460	2,720
0 B & S	.37	.0829	97.1	513	10.300	.16050	.84740	960	2,150
1 B & S	.33	.0657	77.0	407	12.990	.20250	1.0692	920	1,710
2 B & S	.30	.0521	61.0	323	16.400	.25540	1.3486	730	1,355
3 B & S	.26	.0413	48.5	256	20.620	.32200	1.7002	579	1,075
4 B & S	.23	.0327	38.5	203	25.970	.40600	2.1438	450	852

Elastic limit=14,000 lbs. per square inch.

Ultimate strength=26,000 lbs. per square inch.

due to the electro-static repulsion of the particles of water from the wires, which prevents their forming into sleet, or else a sufficient rise in temperature exists in the wire due to current to prevent freezing. Sleet would certainly not stay on a wire during a high wind.

Table I gives the resistance and other properties of pure aluminum cable as now manufactured in sizes from No. 4 B. & S. up to 1,000,000 CM.

being stretched so that it reaches its elastic limit at minimum temperature with the wind blowing at 65 miles per hour actual velocity. The other constants are taken the same as in curves 2, 3, 4 and 5.

Table IV shows deflections at various temperatures and span lengths without wind for No. 2 B. & S. aluminum, the wire being stretched to its elastic limit at minimum temperature, with the wind blowing 65 miles per hour actual

TABLE II.—Dimensions and Resistances of Aluminum Stranded Cables Equivalent in Resistances to Standard Sizes Copper. Resistance at 75 Degree F. Resistance per Mil-Foot, 62 Conductivity at 75 Degrees F.=16.949 Ohms.

SIZE COPPER.	Aluminum equivalent. Circular mils.	Diameter. Aluminum. Stranded inches.	Area. Aluminum. Square inches.	Ohms per 1000 feet. Aluminum.	Ohms per mile. Aluminum.	Pounds per 1000 feet. Aluminum.	Pounds per mile. Aluminum.	Feet per pound. Aluminum.	Elastic limit. Aluminum.	Ultimate strength. Aluminum.
1,000,000 CM	1,580,700	1.45	1.2415	.01072	.05660	1454	7678	.6878	17380	32280
950,000 CM	1,501,700	1 41	1.1794	.01129	.05961	1381	7291	.7242	16510	30660
900,000 CM	1,422,600	1.38	1.1172	.01191	.06288	1309	6912	.7640	15640	29050
850,000 CM	1,343,500	1.34	1.0552	.01261	.06658	1236	6526	.8085	14770	27430
800,000 CM	1,264,400	1.29	.9924	.01340	.07075	1163	6141	.8600	13900	25820
750,000 CM	1,185,500	1.25	.9310	.01430	.07550	1091	5761	.9166	13030	24210
700,000 CM	1,106,300	1.21	.8690	.01533	.08094	1018	5375	.9824	12160	22590
650,000 CM	1,027,300	1.17	.8076	.01650	.08712	945.0	4989	1.0582	11300	20980
600,000 CM	948,400	1.12	.7448	.01787	.09435	872.5	4554	1.1460	10430	19370
550,000 CM	869,400	1.07	.6828	.01884	.09947	799.8	4223	1.2551	9560	17750
500,000 CM	790,400	1.02	.6208	.02144	.11320	727.2	3839	1.3733	8690	16140
450,000 CM	711,150	.97	.5586	.02383	.12580	654.4	3457	1.5282	7820	14520
400,000 CM	632,300	.92	.4966	.02680	.14150	581.7	3071	1.7192	6950	12910
350,000 CM	553,150	.86	.4345	.03064	.16180	509.0	2687	1.9648	6080	11300
300,000 CM	474,200	.79	.3724	.03574	.18870	436.2	2303	2.2927	5210	9680
250,000 CM	395,150	.72	.3103	.04289	.22650	363.5	1919	2.7511	4340	8070
0000 B & S	334,450	.66	.2627	.05068	.26760	307.7	1625	3.2500	3680	6830
000 B & S	265,250	.59	.2083	.06390	.33740	244.0	1288	4.0985	2920	5420
00 B & S	210,300	.53	.1652	.08060	.42550	193.5	1022	5.1680	2310	4290
0 B & S	166,850	.47	.1310	.10170	.53700	153.5	810.5	6.5150	1830	3410
1 B & S	132,300	.42	.1039	.12810	.67640	121.7	642.6	8.2170	1450	2700
2 B & S	104,900	.37	.0824	.16160	.85320	96.5	509.5	10.3633	1150	2143
3 B & S	83,190	.33	.0653	.20370	1.0760	76.5	403.9	13.0730	914	1700
4 B & S	65,980	.30	.0518	.25690	1.3563	60.7	320.5	16.477	726	1350
5 B & S	52,320	.26	.0411	.32390	1.7103	48.2	254.5	20.750	575	1070
6 B & S	41,490	.23	.0326	.40850	2.1570	38.2	201.7	26.180	456	850

Conductivity copper calculated for 98, Matthiessen standard scale.
Elastic limit aluminum=14,000 lbs. per square inch.
Ultimate strength aluminum=26,000 lbs. per square inch.

Table II gives the resistance and other properties of aluminum cable in sizes equivalent in resistance to standard sizes of copper from No. 6 B. & S. to 1,000,000 CM.

Table III gives the deflections which would occur at various temperatures without wind in three sizes of aluminum cable for various span lengths up to 1000 feet, the cable

velocity. It is safe to follow this table for all sizes of cable, for the larger sizes will have slightly smaller deflections without exceeding their elastic limit on account of their greater relative strength.

Aluminum is a highly electro-positive metal. Consequently great care should be taken where contact is made

TABLE III.—Deflections in Feet Without Wind. Aluminum Cable.

Rise above minimum temperature F degrees.	Span. 200 Foot			400 Foot Span.			600 Foot Span.			800 Foot Span.			Span. 1000 Foot		
	553,150 CM.	265,400 CM.	132,300 CM.	553,150 CM.	265,400 CM.	132,300 CM.	553,150 CM.	265,400 CM.	132,300 CM.	553,150 CM.	265,400 CM.	132,300 CM.	553,150 CM.	265,400 CM.	132,300 CM.
0 Degrees	.42	.45	.46	1.80	1.95	2.20	4.3	5.1	6.2	83.6	10.3	14.0	13.9	18.6	26.0
20 Degrees	.51	.52	.55	2.20	2.42	2.75	5.1	6.1	7.2	9.5	11.7	15.4	15.6	20.3	27.6
40 Degrees	.65	.65	.69	2.70	2.90	3.40	6.0	7.1	8.4	10.8	13.2	16.9	17.3	22.0	29.0
60 Degrees	.83	.85	.92	3.35	3.70	4.20	7.0	8.2	9.7	12.3	14.7	18.3	19.1	23.8	30.5
80 Degrees	1.07	1.13	1.30	4.15	4.50	5.10	8.2	9.5	11.0	13.8	16.4	19.6	20.8	25.5	31.8
100 Degrees	1.57	1.65	1.82	5.05	5.45	6.00	9.5	10.8	12.2	15.4	17.7	20.9	22.5	27.1	33.1
120 Degrees	2.20	2.27	2.45	6.00	6.40	7.00	10.8	12.0	13.3	16.9	19.1	22.2	24.2	28.6	34.4
140 Degrees	2.75	2.80	2.95	6.90	7.35	7.85	11.9	13.1	14.4	18.3	20.4	23.4	25.9	30.0	35.8
150 Degrees	2.97	3.03	3.10	7.20	7.78	8.50	12.5	13.6	15.7	19.0	21.5	25.5	26.7	31.5	37.5

Wire stressed to elastic limit at minimum temperature with 65 miles per hour actual wind velocity.

TABLE IV.—Deflections of Aluminum Wire Without Wind.

Deflections in Inches. Maximum Tension 14,000 Pounds per Square Inch at Minimum Temperature with Wind 65 Miles per Hour Actual Velocity.

Rise Above Minimum Temperature F. °	Length of Span					
	200 ft.	180 ft.	160 ft.	140 ft.	120 ft.	100 ft.
0	6.30	5.30	4.20	3.10	2.20	1.70
10	7.00	5.70	4.50	3.40	2.40	1.75
20	7.80	6.40	5.10	3.80	2.80	1.90
30	8.80	7.25	5.75	4.50	3.20	2.20
40	10.20	8.40	6.70	5.20	3.80	2.70
50	12.00	9.80	7.80	6.40	4.60	3.30
60	14.00	11.50	9.40	7.50	5.60	4.00
70	16.50	14.00	11.50	9.20	7.00	5.20
80	19.75	17.00	14.25	11.40	8.90	6.80
90	23.10	20.00	16.80	13.80	10.30	8.75
100	26.60	23.30	20.00	16.60	13.10	10.80
110	29.75	26.60	23.00	19.50	16.25	13.10
120	33.45	29.75	25.75	22.20	18.70	15.20
130	36.75	32.80	28.70	24.50	20.80	17.20
140	40.00	35.75	31.50	26.80	22.80	18.80
150	43.00	38.40	33.60	29.10	24.80	20.30

Calculations made for No. 2 B. & S. stranded conductor.

with other metals to keep the joint free from moisture, otherwise galvanic action will be set up which will rapidly destroy the aluminum.

The fact that aluminum is one of the principal constituents of the earth's crust leads one to believe that some day its cost will be very low. If that condition ever arrives aluminum will probably become the principal metal for the conduction of electric current.

STARTING A GENERATOR.

Run the generator for a short time with its field circuit open (the field can most conveniently be opened at the rheostat), noting, as in the case of the motor, whether the armature oscillates and the oil rings carry oil. Shut down and replace the field wire in the rheostat, and see that all field resistance is in circuit.

Bring the generator to normal speed, and then gradually cut out the resistance of the rheostat, until normal voltage is obtained. Now note the operation of the machine, and see if the armature still oscillates freely in its bearings; if so, the generator is ready for its load. In case the generator does not build up to voltage when the field resistance is cut out of the circuit (with the generator running at proper speed) it will be found that either the residual magnetism has been lost, or that the shunt fields are not properly connected. In the former case, separately excite the fields from some other source of power for a short time. If, on reconnecting the fields, the generator does not build up, it is probable that the fields are wrongly connected; in this case reverse the leads as indicated on the connection diagrams. Also examine the brushes carefully to see that they make good contact with the commutator. If the machine does not then build up to voltage, an electrician should be called in to locate the trouble.

When the generator is excited to normal voltage, close the main switch. In the case of a shunt wound generator, to maintain the normal voltage as the load increases, it will be necessary to cut some of the resistance out of the rheostat.

In the case of a compound wound generator, if, as the load is increased with the speed remaining constant, the voltage drops to any great extent, it is probable that the series coils are opposing the shunt, and it will be necessary to reverse the series leads.—Allis-Chalmers Instruction Book.

XII. THE MAINTENANCE ORGANIZATION.

Lecture delivered to the Class in Electrical Engineering by Mr. C. E. Fleager of the Pacific Telephone Company, on March 20, 1907, at the University of Washington, Seattle, Wash.

In talking tonight on the maintenance organization I have chosen this subject with the object in view of pointing out the necessary divisions of work and force necessary to keep the complete plant in repair up to the standard on which I assume the original plant has already been built and put in service. I also wish to give a few of the causes of trouble to telephone apparatus and what can be done to prevent and to clear them.

Last week's talk covered the central office portion of the telephone exchange plant, but I wish to again give the short summary of the divisions so that they may be fresh in our minds while dealing with the maintenance of the whole plant.

The central office was divided into the following divisions:

Building.
Protective Apparatus.
Main Distributing Frame.
Intermediate Distributing Frame.
Power Plant.
Switchboard.
Special Desks.

In addition to the central office divisions we have the following other divisions of the whole plant:

Underground Cable Plant.
Aerial Cable Plant.
Aerial Wire Plant.
Subscribers' Stations.

In taking up the maintenance of these divisions I am assuming that the work of all divisions is under the direction of one man whom I shall call the Wire Chief. It is best in my opinion to have all the work of these divisions under the direction of one man as their relations to each other are so interwoven it would only result in friction, no matter how closely the men in charge would co-operate were the responsibility divided. Of course, in some of the larger exchanges this work may become so heavy as to be too much for one man to attend to all the details. In such a case, I would still continue with one head who could have such assistants assigned to particular branches as are necessary.

The Wire Chief's natural question is "What men will I require, and what will the work be in each of the different divisions, and how can I organize to keep each branch going in proper unison with the others?"

Taking our first subdivision of the central office plant, the building, we find a thing which is common to most businesses, and while it will need thought and supervision on the part of the Wire Chief it is so common that I do not think we need to discuss it here. The men required will be one or more janitors, the number, of course, depending upon the size of the building and number of persons entering daily.

The protective apparatus, consisting of carbon arresters and heat coils, is subject to trouble due to disintegration of the carbon blocks or the opening of the heat coils. The first causes the telephone line to become grounded, resulting in the operators or line signals failing to clear properly, in the inability of the operator to ring the subscriber's bell or in the proper quietness of the line being disturbed, due to foreign electric currents entering the line from the ground or earth. This disintegration of the carbon is caused by the jumipng or loosening of a small particle of the carbon which lodges in such a way as to temporarily connect the two carbons, one of which you know is connected to earth and the other to one of the line wires. In clearing this trouble it is only necessary to remove the carbons and rub them on some nearly smooth surface, such as a piece of paper or soft cloth. This tends to wipe off any loose particles. To prevent the particles lodging, the mica, which separates the two blocks, is notched and the notch should be

placed so that gravity will tend to make the particles fall clear of the arrester.

This trouble does not occur with great frequency as only in the case of a general electric storm will the telephone wires become generally in contact with current of sufficient voltage to jump across the air gap. In the case of an electric storm, immediately after the storm has passed, the wire chief can assign men to examine and clean all carbons, but as ordinarily little trouble is experienced, very little help will be required for the regular maintenance.

The heat coil trouble is also of small magnitude and except in case of a general cross with some foreign electric current, such as trolley or electric light current, will not need special attention, the trouble being found on test of the usual complaint ticket and referred to rackmen or switchboardmen to clear. In case of general trouble, men engaged in other work can be temporarily placed to make inspection and clear the open coils found. In the case of self-soldering heat coils it will only be necessary to adjust the position of the coil. In the case of the non-soldering type, the heat coil is removed with the aid of a pair of special pliers, placed in the box marked "bad" and a good heat coil installed.

The maintenance of the main distributing frame and intermediate distributing frame will not be great outside of the changes in cross-connection wires necessary when telephones are moved from one location to another, connected or disconnected. This work, however, will require the attention of one man in medium-sized exchanges and two men or more in larger exchanges. While this work can be classed as strictly maintenance work, yet it can hardly be called construction work, and I am of the opinion it should be included under the general maintenance head. The changes made in the cross connections must be recorded, and as these records naturally fall to the wire chief's department to handle, they being the ones who deal with them constantly, the wire chief should be in charge of the parties making and recording the changes. This man, known as rackman, will do his work on written orders, usually in the form of blanks properly filled out by a clerk known as the line order clerk. He can also assist the testers in locating trouble on the lines by connecting test trunks to the proper lugs on the main distributing frame. This test trunk terminates in a piece of apparatus on the main distributing frame known as a "shoe." It is connected with a flexible cord and is so arranged that when the heat coils are removed it can be placed between the springs, allowing the tester to connect his testing apparatus to the outside or inside line or to connect the two together.

The rackman can also assist in clearing trouble in heat coils or carbons when the tester has located trouble there. The general maintenance of the racks consists of keeping the dirt and dust clear and in inspection of cross-connecting wires where they are connected to the terminals to see there is not liable to be trouble.

Such cross-connection wire as the rackman may disconnect should be pulled out of the frame, and if of sufficient length to be used again and undamaged should be hung up or coiled up for use in connecting new telephones. A supply of cross-connection wire should be placed on a spool free to revolve and located in a handy place. Soldering tools and solder should have a place in which to keep them, usually close to the soldering tool heater. It should be the rackman's duty to keep them in neat order.

The power plant is an expensive and important portion of the exchange and needs skilled attention. As charging is usually done during the daytime, a skilled attendant should have nothing else to take his attention but his machines and batteries. He should daily see that the emergency machines are in working order and that the usual working machines are not in need of repairs or attention. He should be supplied with record blanks on which to record daily use of machines and any remarks which might become of use at a future time in determining cause of trouble in any portion of the plant. He should also be supplied with a chart on which to record daily the work the storage batteries perform and discharge, and charge readings of specific gravity, voltage, temperature, etc. He should also note any change appearing in the batteries which might lead to trouble if not properly attended to. It should be this man's duty to see that his portion of the plant is kept clean, and tools, oil cans, waste, etc., in proper place and proper supply on hand.

The maintenance of the switchboard requires especial training on the part of the men employed at it. Its parts are delicate and unless trouble is properly cleared the results may be rapid depreciation. The parts of the switchboard are so numerous it will be practically impossible to give you all the causes of trouble. Some of the principal ones may be mentioned. Relays collect dust and their local contacts corrode or become dirty, resulting in poor contact when in operation or at rest, thereby causing the failure of the circuit to operate as it should. This can be prevented to a large extent by dust shields for each relay and overcome by cleaning the dust or corrosion away from the contact. This must be done carefully or the adjustment of the armature will be disarranged. Should this occur, it will be necessary to readjust and we should therefore be provided with some portable adjusting set. This set is made up in a convenient form with a handle and provided with keys to produce artificially the condition under which you wish the relay to be adjusted to. Proper tools should be used in adjusting relays systematically tested for adjustment. This can be done rapidly during the hours when the traffic is light (usually midnight to 5 a. m.). This systematic testing tends to head off any trouble of adjustment that might be appearing.

Cords are subject to constant wear and are liable to wear out or become in trouble at any time. A systematic test made every day should again be of service in anticipating trouble. Such trouble as is found either by this test or by failure of the cord during business hours should be cleared by the removal of the cord and substitution of another, the cord in trouble being repaired out of the board during odd moments or at another time by some employee to whom the work is regularly assigned.

Wiring of jacks, keys, relays, etc., may become damaged due to accidental reasons. This can usually be readily found by switchboardmen from trouble reported on the particular circuit in which it is located. An inspection of this wiring should be made at regular intervals by competent men to determine that all trouble has been properly repaired and to repair and put in order such as has not.

In locating touble in the wiring except in cases in the multiple, the trouble can readily be found by opening the cross-connecting wires and then inspecting the various points in the wiring where the trouble could occur. In case of trouble in the multiple this is not feasible, as in almost every case the wires are located out of sight in the pile of multiple cabling. Several methods can be employed in locating this trouble. One of the simplest requires the use of a battery and a telephone receiver. Battery is connected in series with one of the two wires that are crossed and the receiver is connected across the wires from jack to jack until in the jack in which the trouble is located the cross will not allow of current passing through the receiver while in all other jacks a certain portion of the current will shunt through the receiver. Opens are found with the use of the same apparatus. As most of the telephone circuits have one side of the battery connected to one wire and the other side on the other wire you can readily see what little apparatus is required.

The cleaning of the switchboard is an item often overlooked and in my opinion should receive regular attention from some employee. Dust collects easily in all of the multiple jacks, on cables under the board, etc. A compressed

air plant or vacuum pump would be of great assistance in this work. The switchboard frames should be polished regularly if the finish is to be kept up properly.

As the continued operation of the apparatus is desired, a competent man should be on duty at all hours who can immediately tend to any failure, such as the blowing of a fuse. This man can be repairing such trouble as is reported on the usual complaint ticket, as he would be around the switchboard within easy call at all times.

The various circuits, such as subscribers' line circuits, trunk circuits, operators' busy test circuits, etc., should be tested at regular intervals. This can readily be included with the cord and relay adjustment tests mentioned a short time ago. In fact, the portable test sets are usually wired to do this, using the maximum and minimum line resistances as a basis to work from.

The maintenance of the special desks is included in the maintenance of the switchboard as its class is exactly the same.

In the maintenance of the underground cable plant, we find that practically all our troubles come from one cause—the opening of the lead sheath, allowing water to enter and destroy the insulation of the wires. The insulation is now always of paper which draws water easily. The opening of the sheath may be caused by any one of several causes, the principal ones of which are cracks in the joints, careless handling of tools by workmen, working alongside the cables, malicious injury and electrolysis. The three former can not be prevented entirely, but of course can be minimized to a large extent by careful supervision. The latter can be prevented by proper tests often enough to eliminate injury. A method for finding if electrolysis is liable to be occurring is to make potential measurements of the cable sheaths, comparing it to the actual earth potential and to water pipe sewer and street car rail potentials. Where the current is found to be flowing between our cables and some other conductor in the direction liable to cause trouble a bond should be attached, thereby preventing any electrolytic action.

Insulation measurements should be made on conductors in all cables at frequent intervals in order to obtain, if possible, advance information as to coming trouble. When trouble actually shows up it is located by means of the Wheatstone bridge, and is cleared by removing the lead sheath from the damaged portion and boiling the cable in paraffine, thus driving away the water. If this is impossible, owing to position or extent of trouble, a new piece of cable is connected in place of the damaged piece.

If the exchange is of any size, it is well to keep one man constantly working on the cables with his Wheatstone bridge, as very often when the weather is dry one pair only of a cable will come in trouble, and, while he may not be able to locate what has caused the trouble, it may mean something serious when the first rain comes, and his measurements of the one pair may be the means of more quickly locating the trouble.

Underground cables should be inspected in the manholes at regular intervals. It is also well to patrol the underground each day to locate and stop possible interference with the cables by other companies digging in or across the street.

The maintenance of the aerial cables follows very closely that of the underground cables, and needs no further discussion.

The maintenance of the aerial wire plant should not be a large factor in the maintenance of the whole plant, as in modern systems the aerial wire is reduced to a minimum, an all-cable plant being desirable. The aerial wires should be given the proper amount of tension, the extremes of temperatures to be taken into account in determining the exact sag to be placed in the wires while constructing.

The aerial wire plant is very susceptible to sleet and wind storms. A special maintenance force will usually be required after such a storm, and can be drawn from the construction forces.

Our next subdivision, the subscriber's station, is one that next to the central office is in more danger of getting into trouble. It is also the part that gets the least educated handling, that is, it is the portion of the plant coming into close touch with the public and, of course, very often gets rough and careless handling. The construction of the subscriber's instrument can, to a great extent, overcome the difficulties and troubles experienced. All working parts, as far as possible, should be inside of the case or framework of the telephone. With the central energy system the only portion of a wall set that should have any great amount of wear would be the cord connecting the receiver. The receiver is the only portable portion of this set, and may become broken by careless handling, as may the transmitter mouthpiece, which is not of great strength.

With the desk, or portable set, the maintenance is usually considerably greater, as the whole set is not fixed or fastened, and easily gets knocked over.

In the handling of the maintenance of this portion of the plant I have found it to be my experience that better results can be obtained if a certain portion of the exchange is assigned to one man and he made responsible for the condition of it. His work should include the regular inspection to be reported to the Wire Chief at the time of inspection, and the line to be "Placed on test," and talking, ringing and resistance tests to be made. The condition of the instrument as to neatness, general appearance, wear, etc., should be recorded by the Wire Chief. The troubleman should be required to carry such tools and material as is necessary to place the instrument in as good order as when it was originally installed, if possible.

We have covered the principal troubles to be found and means of clearing same, so let us now look to the method and plan to be followed in collecting, recording, testing and reporting such daily troubles as occur. Naturally, our first thought must be to the method of collecting such trouble complaints as arise. As the public cannot distinguish between the various classes of trouble, we must refer all complaints to one department. This is what I have termed our complaint department. Such subscribers as have complaints to make should be referred and connected to this department, which is situated at a desk, termed the complaint desk. The clerk or operator of this desk should be sufficiently versed in the various kinds of trouble to readily obtain from the complaining party all possible useful information which information should be recorded on blanks provided for the purpose. After the blank has been filled out with all the information obtainable the party can be advised that the trouble will be properly attended to and cleared. The blank should then be assigned a serial number and the important information recorded in a book supplied for that purpose. Time of day at which the complaint is received should be recorded both on the blank and in the book.

If the complaint is of a service nature it should be referred to the operating department. If the complaint is due to defective working of any of the apparatus it should be immediately referred to the Wire Chief's desk for testing and clearing. The Wire Chief should have at this desk a number of testers who can immediately take the complaint ticket and place the line on one of his test trunks to determine where and what the exact trouble or defect may be. This tester, to obtain this information, must be familiar with the entire workings of the exchange, as well as familiar with his testing circuits, as upon his correctly ascertaining the location of the trouble will depend the quick removal of it.

When the trouble is determined and located the tester must assign the cause of trouble to the proper party for

attention. To do this he must ascertain the employee to whom has been assigned the particular district or class of trouble to which this case belongs, and when that employee is connected with the Wire Chief's desk the trouble can be referred to him for clearing. The desk should be provided with pigeon holes properly marked, so that the complaint ticket can be placed on file immediately when it is tested and assigned. As the trouble-man calls for test the record of such test should be made on the ticket and ticket again filed. When the trouble is finally cleared, the ticket should be endorsed with the time of day and cause of trouble and returned to the complaint department.

The complaint department will enter in their complaint book the information, endorsed by the Wire Chief, regarding time cleared and cause of trouble, and the ticket laid to one side to be filed with the balance of the day's tickets. As claims for damages due to trouble on the lines may occur, these tickets should be filed so they may readily be located again, although the exact date may not be known. In the case of a party line, the subscriber making claim may not have been the subscriber making report on the trouble. It is, therefore, necessary to file these tickets in numerical order in accordance with the circuits on which the trouble occurs. For convenience, they are usually filed in groups of one hundred circuits, each month separate.

I have spoken of the complaint ticket being of the proper form. What form should this be? One point I think has often been overlooked, and to me seems important, it being that unless the Wire Chief knows what trouble has existed previous to the case he is now working on, he is apt to overlook some important trouble. This is particularly true of trouble of an intermittent nature. Such trouble may be reported, yet when the Wire Chief tests the line he finds it working perfectly. This may occur time after time, and unless some one pays particular attention to it the trouble will still exist. A good way to overcome this, it seems to me, would be to have a trouble ticket for each circuit working in the exchange on file at the complaint desk. This ticket could be made up of sufficient size to allow ten to twenty-five cases of trouble to be recorded on the same ticket. When trouble is reported, the complaint operator can withdraw it from the file, endorse the new trouble on it, and, if the Wire Chief finds it O. K. on test, he can, by referring to the trouble that has previously been reported, know if it is some old condition needing special attention or if it is some case of trouble lasting only temporarily. This form of complaint ticket would also be of greater weight as evidence in the trial of damage claims.

Summing up the various men needed to handle the maintenance department, we might build up the following:

Wire Chief, testers, switchboard trouble-men, instrument trouble-men, power-plant attendant, rackman, line-order clerks, recording clerks, cable trouble-men, janitors.

San Francisco, Cal.—The proposed combined fresh and salt water system of fire protection of San Francisco was explained fully at a meeting held at the Merchants' Exchange last week, to which the special committee of the Merchants' Association had invited representatives of the Merchants' Exchange, Chamber of Commerce, Board of Trade, and Pacific Board of Fire Underwriters. From what was said at and after the meeting it appears that the project will meet with the approval of the business men and also of the insurance men whose interests claim consideration just now. The final approval of the insurance people will, however, be withheld until the arrival of Chief Engineer Robinson, of the National Board of Fire Underwriters, who is coming here from Chicago to look over the plans and suggest whatever modifications or improvements he thinks necessary.

CALIFORNIA MIDLAND RAILROAD.

Construction has been started on the roadbed of the California Midland Railway, which will connect the mines of Nevada and Placer Counties with Marysville. From Marysville the new road will extend thirty-four miles east to Limekiln Junction. From here one branch will be built south, seventeen miles, to Auburn, on the Southern Pacific Railway. A second branch will run twelve miles northeast to Grass Valley, which is joined to Nevada City by the Nevada County Traction Company's electric road. Hammond, the center of the Yuba dredging industry, will be connected by a one and one-half-mile spur from the main line at Marygold, eight miles east of Marysville.

The seventy miles will be operated with 1,200-volt, direct current, distributed between sub-stations by an underrunning, inverted-contact third-rail. Current will be purchased from the California Gas & Electric Corporation, which has hydraulic generating plants and 60,000-volt transmission lines in this territory. There will be four sub-stations of reinforced concrete, each equipped with a 400-kilowatt capacity motor-generator set, and the necessary step-down transformers. The motor-generator sets will each comprise one 60-cycle motor, direct connected to a 1,200-volt, 400-kilowatt generator. The sub-stations will be placed at Marygold, a point midway between Marygold and Limekiln, at Limekiln, and north of Auburn. The high-voltage alternating current will be stepped down and converted at each sub-station and distributed between the sub-stations through an inverted contact rail. It is proposed to use a special low-carbon steel rail weighing 22.4 pounds per yard. The section will have an inverted "T" form, being supported by channel-section brackets twelve feet apart. These channel-iron brackets will be spiked to the ties, and each will support a porcelain insulator, from which will hang a wrought-iron stirrup. The stirrups, in turn, will be keyed to the web of the inverted T-section. It is estimated that with this light rail section, permissible on account of the high voltage, there will be a weight of but 100 pounds to be supported by each insulator. The inverted T-section may carry, if necessary, four No. 0000 auxiliary copper feeders.

Low-carbon steel has a conductivity one-eighth that of the same cross-section of copper, consequently the equivalent cross-section of the underrunning steel rail will be 345,000 circular mils, and the conductor will offer a resistance, including bonds, of 0.16 ohm per mile.

Each passenger car will be equipped with four 75-horsepower, 600-volt motors, connected two in series for 1,200-volt operation. Potential relays will be shunted across the motor terminals, to eliminate possibility of trouble from the slipping of one motor of a pair. A pantograph trolley is to be used to supply current to the motors in towns where there are trolley wires, but in the open country the current will be taken up by four underrunning collector shoes. Compressed air will operate the brakes and control the changing from the third rail to the trolley. The cars will be fifty-two feet long. A block-signal system will be put in.

The line will run through a picturesque section of the Sierra Nevada foot-hills, and will open up not only the mines, but also a large agricultural country, to a cheaper and more direct transportation to market. The maximum grade will be one of three per cent. for seven miles. Several large bridges will be necessary, and, as surveyed, considerable cut and fill will have to be done. The Yuba River and marsh, near Marysville, will be crossed by a 9,000-foot trestle.

C. C. Manker, of San Francisco, designed the electrical system, under the direction of John Martin, president of the California Midland.

Electrical Construction for the Architect

CHANGES IN NATIONAL ELECTRIC CODE. APPROVED ELECTRICAL DEVICES.

Theatre Wiring.

Among other changes made in the National Electric Code at the recent meeting of the Electrical Committee of the Underwriters' National Electrical Association, was the abolishment of "Rule 65A: Moving Picture Machines," and the substitution thereof of "Special Rules and Requirements for the Installation of Wires and Apparatus for Electric Light, Heat and Power in Theatres where potential of system does not exceed 250 volts."

Special rules and requirements for the installation of wires and apparatus for electric light, heat and power in theatres where potential of system does not exceed 250 volts.

All wiring, apparatus, etc., not specifically covered by special rules herein given must conform to the standard rules and requirements of the National Electric Code.

In so far as these rules and requirements are concerned, the term "theatre" shall mean a building or part of a building in which it is designed to make a presentation of dramatic, operatic or other performances or shows for the entertainment of spectators which is capable of seating at least four hundred persons, and which has a stage for such performances that can be used for scenery and other stage appliances.

(a). Services:

1. Where source of supply is outside of building, there must be at least two separate and distinct services, and where practicable they must feed from separate street mains. The second service must have at least sufficient capacity to supply all emergency lights.

2. Where source of supply is an isolated plant within same building, an auxiliary service of at least sufficient capacity to supply all emergency lights must be installed from some outside source, or a suitable storage battery within the premises may be considered the equivalent of such service.

(b) Stage:

1. All permanent construction on stage side of proscenium wall must be approved conduit with the exception of cables to border and switchboard wiring.

2. **Switchboards.**—Must be made of non-combustible, non-absorptive material, and where accessible from stage level, must be protected by an approved guard rail to prevent accidental contact with live parts on the board.

3. **Footlights.**—Must be wired conduit construction, each lamp receptacle being enclosed within an approved outlet box, the whole to be enclosed in an iron trough, metal to be of a thickness not less than No. 20 gage, or each lamp receptacle can be mounted on or in the cover of an iron box so constructed as to enclose all the wires and live parts of receptacles.

4. **Borders:**

(a.) Must be constructed of iron of a thickness not less than No. 20 gage, treated to prevent oxidization, be suitably stayed and supported by a metal framework, and so designed that flanges of reflectors will protect lamps.

(b.) Must be wired conduit construction, each lamp receptacle to be enclosed within an approved outlet box, the whole to be enclosed in an iron trough, or each lamp receptacle may be mounted on or in the cover of an iron box, so constructed as to enclose all the wires and the live parts of receptacles, metal to be of a thickness not less than No. 20 gage.

(c.) Must be provided with suitable guards to prevent scenery or other combustible material coming in contact with lamps.

(d.) Cables must be continuous from stage switchboard to border, conduit construction must be used from switchboard to point where cables must be flexible to permit of the raising and lowering of border, and flexible portion must be enclosed in an approved fireproof hose or braid and be suitably supported.

Exception.—Junction boxes will be allowed on fly door and rigging loft in existing theatres where the wiring has been completed and approved by Inspection Department having jurisdiction.

(e.) For the wiring of the border proper, wire with slow-burning insulation should be used.

(f.) Must be suspended with wire rope, same to be insulated from border by at least two approved strain insulators properly inserted.

5. **Stage Pockets:**

Must be of approved type controlled from the switchboard, each receptacle to be of not less than fifty amperes rating, each receptacle to be wired with a separate circuit to its full capacity.

6. **Proscenium Lights:**

Must be so installed that they cannot interfere with the operation of or come in contact with curtain.

7. **Scene Docks:**

Where lamps are installed in scene docks, they must be so located and installed in such manner that they will not be liable to mechanical injury.

8. **Curtain Motors:**

Must be of iron-clad type and installed so as to conform to the standard rules and requirements of the National Electrical Code.

9. **Control for Stage Flues:**

(a.) In cases where dampers are released by an electric device, the electric circuit operating same must be normally closed.

(b.) Magnet operating damper must be wound to take full voltage of circuit by which it is supplied, using no resistance device, and must not heat more than normal for apparatus of similar construction. It must be located in loft above scenery and be installed in a suitable iron box with a tight, self-closing door.

(c.) Such dampers must be controlled by at least two standard single-pole switches, mounted within approved iron boxes, provided with self-closing doors without lock or latch and located one at the electrician's station and others as designated by the Inspection Department having jurisdiction.

(c.) Dressing Rooms:

1. Must be wired in approved conduit.

2. All pendant lights must be equipped with approved reinforced cord or cable.

3. All lamps must be provided with approved guards.

(d.) Portable Equipments:

1. Arc lamps used for stage effects must conform to the following requirements:

(a.) Must be constructed entirely of metal, except where the use of approved insulating material is necessary.

(b.) Must be substantially constructed and so designed as to provide for proper ventilation and to prevent sparks being emitted from lamp when same is in operation, and mica must be used for frame insulation.

(c.) Front opening must be provided with a self-closing hinged door frame in which wire gauze or glass must be inserted, excepting lens lamps, where the front may be sta-

tionary and a solid door be provided on back or side.

(d.) Must be provided with a one-sixteenth iron or steel guard having a mesh not larger than one inch, and be substantially placed over top and upper half of sides and back of lamp frame; this guard to be substantially riveted to frame of lamp, and to be placed at a distance of at least two inches from the lamp frame.

(e.) Switch on standard must be so constructed that accidental contact with any live portion of same will be impossible.

(f.) All connections in lamp and at switch and rheostat must be provided with approved lugs.

(Note: Referred for re-wording.)

(g.) Rheostat, if mounted on standard, must be raised to a height of at least three inches above floor line, and in addition to being properly enclosed must be surrounded with a substantially-attached metal guard having a mesh not larger than one square inch, which guard is to be kept at least one inch from outside frame of rheostat.

(h.) A competent man should be provided for each standard, and not more than two arc lamps should be mounted on one standard.

(Note: Referred for re-wording so that one man may have two lamps in charge if in sight of each other, and not more than ten feet apart.)

2. **Bunches:**

(a.) Must be substantially constructed of metal, and must not contain any exposed wiring.

(b.) The cable feeding same must be bushed in an approved manner where passing through the metal, and must be properly secured to prevent any mechanical strain from coming on the connection.

3. **Strips:**

(a.) Must be constructed of iron of a thickness not less than No. 20 gage, treated to prevent oxidization, and suitably stayed and supported by metal framework.

(b.) Cable feeding same must be bushed in an approved manner where passing through the metal, and must be properly secured to prevent any mechanical strain from coming on the connections.

4. **Portable Plugging Boxes:**

Must be constructed so that no current-carrying part will be exposed, and each receptacle must be protected by approved fuses mounted on slate bases and enclosed in a fireproof cabinet equipped with self-closing doors. Each receptacle must be constructed to carry thirty amperes without undue heating, and the bus-bars must have a carrying capacity equivalent to the current required for the total number of receptacles, allowing thirty amperes to each receptacle, and approved lugs must be provided for the connection of the master cable.

5. **Pin Plug Connectors:**

(a.) When of approved type, may be used to connect approved portable lights and appliances that do not require more than 660 watts.

(b.) Must be so installed that the "female" part of plug will be on the live end of cable, and must be so constructed that tension on the cable will not cause any serious mechanical strain on the connection.

6. **Lights on Scenery:**

Where brackets are used they must be wired entirely on the inside, fixture stem must come through to the back of scenery and end of stem be properly bushed.

7. **String or Festoon Lights:**

Wiring for same should be approved cable, joints where taps are taken from same for lights to be properly made, soldered and taped, and where lamps are used in lantern or similar devices, lamps must be provided with approved guards. Where taps are taken from cable, they should be so staggered that joints of different polarity will not come immediately opposite each other, and must be properly protected from strain.

8. **Special Electrical Effects:**

Where devices are used for producing special effects, such as lightning, waterfalls, etc., the apparatus must be so constructed and located that all flames, sparks, etc., resulting from the operation cannot come in contact with combustible material.

(e.) Auditorium:

1. All wiring must be installed in approved conduit.

2. All fuses used in connection with lights illuminating all parts of the house used by the audience, must be installed in fireproof enclosures so constructed that there will be a space of at least six inches between the fuses and the sides and face of the enclosure.

3. All exits shall be plainly indicated by a sign at each, the face to be illuminated and bear the word "Exit," the letters of which must not be less than four inches in height, and there must not be more than one set of fuses in any "Exit" sign circuit between service fuses and sign.

4. Exit lights and all lights in halls, corridors or any other part of the building used by the audience, except the general auditorium lighting, must be fed independently of the stage lighting, and must be controlled only from the lobby or other convenient place in the front of house.

(Note: Sections 3 and 4 will probably be re-worded so as to apply if exits are lighted by electricity.)

5. Every portion of the theatre devoted to the use or accommodation of the public, also all outlets leading to the streets and including all open courts, corridors, stairways, exits and emergency exit stairways, should be well and properly lighted during every performance, and the same should remain lighted until the entire audience has left the premises.

6. **Moving Picture Machines:**

(a.) Arc lamps used as a part of moving-picture machines must be constructed similar to arc lamps of theatres and wiring of same must not be of less capacity than No. 6 B. & S. gage.

(b.) Rheostats must conform to rheostat requirements for theatre arcs.

(c.) Top reel must be encased in an iron box with hole at the bottom only large enough for film to pass through, and cover so arranged that this hole can be instantly closed. No solder to be used in the construction of this box.

(d.) A box must be used for receiving the film after being shown, with a hole in the top only large enough for the film to pass through freely, with a cover so arranged that this hole can be instantly closed. An opening may be placed at the side of the box to take the film out, with a door hung at the top, so arranged that it cannot be entirely opened, and provided with spring catch to lock it closed. No solder to be used in the construction of this box.

(e.) The handle or crank used in operating the machine must be secured to the spindle or shaft, so that there will be no liability of its coming off and allowing the film to stop in front of lamp.

(f.) A shutter must be placed in front of the condenser, arranged so as to be readily closed.

(g.) Extra films must be kept in metal box with tight-fitting cover.

(h.) Machines must be operated by hand (motor-driven will not be permitted).

(i.) Picture machine must be placed in an enclosure or house made of suitable fireproof material, be thoroughly ventilated and large enough for operator to walk freely on either side of or back of machine. All openings into this booth must be arranged so as to be entirely closed by door or shutter constructed of the same or equally good fire-resisting material as the booth itself. Doors or covers must be arranged so as to be held normally closed by spring hinges or equivalent devices.

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EDITORIAL.

COMPARATIVE COST OF POWER FROM DIFFERENT SOURCES.

In a recent bulletin of the United States Department of Agriculture Professor C. E. Lucke of the Mechanical Engineering Department of Columbia University and S. M. Woodward, irrigation engineer, give a complete analysis of the cost of power from various sources, primarily for the purpose of contrasting the total cost per unit of output, using alcohol or gasoline and other fuels. Their conclusions are of more than ordinary interest to gas engineers and others connected with the introduction of gas or explosive mixture engines.

As set forth by the authors, the greatest source of power is fuel, and by far the largest part of the power being used comes from steam produced by the use of coal. In point of present use water power stands next to steam in importance, this being the case for two reasons, namely, that water power is among the earliest in point of development, but more largely due to the fact that it is now possible to transform water power into electrical power, which can be transmitted long distances, and so overcome geographical isolation of the sources of power.

Next in quantity produced stands power generated by the gas engine. The principal reason why the gas engine occupies this subordinate position is the fact that engineers have only recently discovered, and are today discovering, how best to build these machines and adapt them to the work they are to do.

The gas engine in its general sense includes all machines in which the fuel mixed with air is burned or exploded within the working chambers, whether the fuel be gas produced from coal, natural gas, vapors of any of the mineral oils, vegetable or animal oils, or alcohol.

The cost of producing power, no matter what the source, necessarily includes interest, depreciation, attendance, repairs, lubricants, and, except with wind, wave, or water power, fuel.

Eliminating water power, fuel is always a most important item, and it is found that labor costs do not differ so widely for the different systems, nor are they so large as the fuel cost. In power production, the lessening of the cost of fuel is of paramount importance.

Based on heat units, the following table is given as showing the cost of energy in fuels:

Fuel	Cost	B. T. U.	B. T. U. per $1.00
Large anthracite,	$6.25 ton	12,500 per lb.	4,500,000
Illuminating Gas	1.00 per 1000 cu. ft.	550 cu. ft.	550,000
Natural Gas	.10 " "	1,000 "	10,000,000
Crude Oil	.04 gal.	20,000 per lb.	3,650,000
Kerosene	.10 "	20,000 "	1,200,000
do	.30 "	20,000 "	400,000
Gasoline	.10 "	20,000 "	1,200,000
do	.30 "	20,000 "	400,000
Grain Alcohol	.30 "	12,000 "	270,000
do do	.40 "	12,000 "	200,000

The above table shows comparatively the cost of energy in heat units with different kinds of fuels. The thermal efficiency of the apparatus used for converting the heat energy into mechanical energy, or as is commonly termed power, affects the cost of fuel per unit of power. The following table, therefore, is of greater value to the power user or producer, as the resultant cost not only takes into consideration the cost of fuel but the efficiency of each machine using a particular kind of fuel.

Fuel and Plant	Fuel per H. P. Hr.	B. T. U. per H. P. Hr.	Thermal Efficiency %	Cost of Fuel	Cost in cts Fuel per H. P. Hr.
Steam Plant	2 to 7 lbs.	25,000 to 100,000	10 to 2.5	$6.25 ton	.57 to 2.2
Producer Gas	1¼ to 2 lbs	14,000 to 25,000	18 to 10	$6.25 ton	.31 to .57
Illuminating Gas	24 cu. ft.	12,000	20	$1. M cu. ft.	2.20
Crude Oil	1.4 pts.	25,000	10	.04 gal.	.68
Gasoline	1.1 pts.	13,400	19	.15 gal	1.70
Alcohol			19	.30 gal.	5.0C

The above figures are based upon a cost of coal of $6.25 per ton. With this price of coal, the cost of fuel per horsepower per hour using the steam engine is .57 of one cent, but with the producer gas plant and gas engine and the same cost of coal, a horsepower hour cost but .31 of one cent.

With fuel cost but $2.50 per ton the corresponding costs are given as .25 of one cent for the steam engine and .14 of one cent for the producer gas plant and gas engine.

As a general conclusion, it must be said that the future of the gas engine using producer gas is most promising, especially in large units. For small isolated plants the crude oil and gasoline engines also have a great advantage over the steam engine, not only in smaller fuel costs, but also in attendance charges.

INDIVIDUALISM vs. SOCIALISM.

In a recent address before the People's Forum, at New Rochelle, Mr. Jacob G. Shurman, president of Cornell University, said:

"In recent times in all progressive countries the functions of government have been considerably enlarged. In the United States, for example, the view of government that has hitherto prevailed is that of an institution for the protection of life and property. It rested on the very wise theory that the less men were governed, the better. But the growing complexity of modern life and the multiplication of material commodities and the varying conditions under which they are produced and exchanged have compelled modern legislatures to enact laws on subjects not only inconceivable to their fathers, but transcending the limitations set by them for the scope of governmental activity. This necessity has produced a change in our attitude twoard the State. We have come to think of it, perhaps, in an exaggerated and dangerous degree, not merely as an institution for the protection of its citizens in their rights, but as an association for the positive promotion of the common interests of all its members.

"Laws for the protection of working people, and for the improvement of their condition, have rapidly increased, both in the United States and in Europe and Australasia. The lead in this so-called 'State Socialism' was taken by Germany, which adopted measures for the insurance of workmen against accident, sickness and old age. New Zealand, under the leadership of the late Richard Seddon, went still further in the same direction, and established in addition a system of compulsory arbitration in labor disputes. In this country and in England factory legislation may be mentioned as an illustration of the same tendency. And, in a different field, the Federal Railway Rate Bill, Pure Food Bill, and Meat Inspection Bill of last year, with their recognition of the need of Government supervision of certain kinds of private property, were by many people regarded as another example of State Socialism.

"For my own part I will add that the presumption is always against any extension of the functions of government, as government is already overburdened and the men who conduct it are not equal to the growing task, being neither demi-gods nor heroes, but mere human beings, little, if any, above the average of their fellows, either in ability or character. No fallacy is more pernicious than the complacent assumptions that a problem is solved when the task of solving it is put on the President, or Governor, Congressman, or Assemblyman, or some lower official of their selection or appointment. The State is not a wise, benevolent, and all-powerful earthly Providence.

"It is a widespread belief that certain political, social, and economical evils can be obviated or mitigated by public ownership of industries which in their nature are monopolistic. Under this conviction cities have become owners of waterworks, gas and electric light plants, tramways, and street cars, and States have purchased or constructed railway, telegraph, and telephone systems, and even undertaken the business of banking and insurance. * * * Now, I do not understand that any appreciable advance toward the millenium has anywhere resulted from the municipal or State ownership of public utilities, though I am far from opposing that system of ownership. I know that in London, where municipal ownership had been carried almost to an extreme, mismanagement, especially in connection with the street cars, the river boats, and the electric service, entailed such enormous municipal debts that the rates of municipal taxes were greatly increased, and the supporters of the municipal ownership policy were overwhelmingly defeated at the elections only a few months ago. I know that in Russia, which is the most perfect exemplar of State and municipal ownership, you find as a consequence a highly-centralized government and a corrupt bureaucracy which is not only morally reprehensible, but which yields in practice the worst service in the civilized world.

"I do not want to see a Government despotism in the United States. I dread the bureaucracy which Government ownership of American railroads would make inevitable. I can see nothing but folly in a policy which would call for Government loans of billions of dollars to purchase the railroads and which would entail the loss of billions of dollars in mismanagement and corruption under political control after the roads had been taken over by the Federal and State Governments. No Government in the world is qualified to go into the railway business, and least of all the Government of the United States, which draws its life from party politics and in which all administrations are necessarily short lived.

"The fact is that wealth is a creation. The colossal fortunes of the millionaires and billionaires, excepting, of course, those that have been dishonestly acquired, are positive contributions to the sum total of human wealth. These fortunes have been created from possibilities of Nature and human society divined by the genius and organizing ability of great captains of industry. The rest of us would not be the richer, but poorer, had these men of economic genius not created their vast fortunes. And I have no doubt that in the material world and in the needs of human nature there are still infinite possibilities of wealth open to any of us who have the genius and skill to utilize them."

TRADE CATALOGUES.

Bulletin No. 1060, from the electrical department of Allis-Chalmers Co., Milwaukee, Wis., describes the new line of machines, designated as Type "AB," which this company is now building for plants in which a belted generator of not exceeding 150 kilowatts output is required. They are of the revolving-field, "self-contained" type, the two bearings being carried with end housings bolted to the stator yoke, the feet of which rest directly on the slide rails. They have no bed plate and the construction is, therefore, somewhat lighter than in Type "AH" belted generators, which are provided with a base and pedestal bearings.

B. F. Sturtevant Company, Hyde Park, Mass., send Bulletin 146, illustrating and describing electric propeller fans, for use whenever large volumes of air are to be moved agianst very low resistances.

PERSONAL.

A. F. Menzin, of San Francisco, has taken a position with the Pacific Power & Light Co. at Redondo, California.

G. B. Euler is superintending the machinery installation in the new plant of the Pacific Power & Light Co. at Redondo.

John E. Van Hoosean of the Sonoma Water and Light Company, Sonoma, Cal., has been in San Francisco during the past week.

J. H. Hallberg, designer and manufacturer of flaming arc lamps and other electrical specialties, has moved from 45 Broadway to 30 Greenwich avenue, New York City.

R. L. Jaynes lectured before the salesmen of the California Electric Works on the Diamond H switch of the Hart Manufacturing Company of Hartford, Con., on May 9th.

J. J. Kline, formerly with the Stanley Electric Co., at Chicago, has been appointed assistant superintendent of the Fort Wayne Electric Co., at Fort Wayne, Indiana.

INDUSTRIAL

WATER-TIGHT TELEPHONE SYSTEM FOR BATTLESHIPS.

The following description and illustrations relate to the special telephone system designed and built by the Holtzer-Cabot Electric Company, Boston, Mass., for the Naval De-

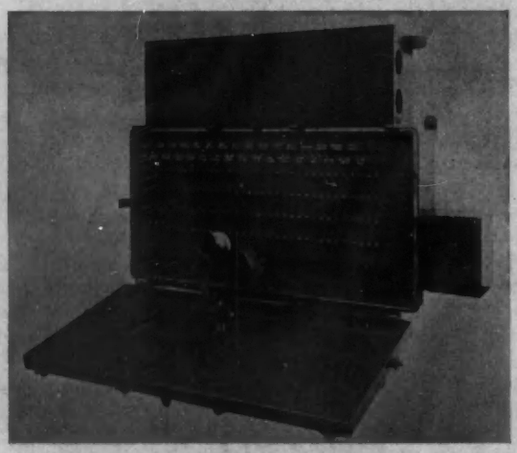


FIGURE 1

partment of the United States Government. Five similar systems were purchased by the Government and installed upon the following battleships: "California," "South Dakota," "Milwaukee," "Indiana" and the "Connecticut." To meet the spe-

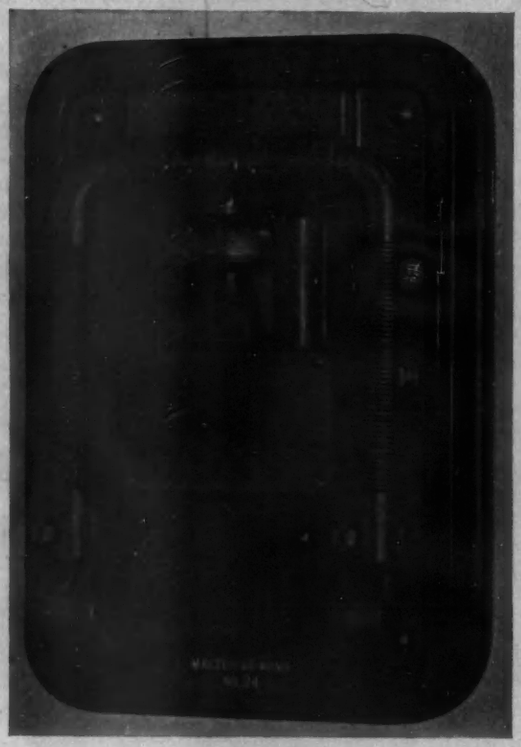


FIGURE 2

cially severe conditions which obtain on shipboard there were incorporated a number of novel and original features.

It was especially desired that the instrument be unaffected by the action of the air, the movement of the vessel, or the concussion of the heavy guns, and the switchboard and exposed stations were to be absolutely water-tight.

Figure 1 represents one of the water-tight stations. The operating parts are mounted on a frame plate which can readily be removed from the case without the use of tools and without disturbing any of the connections. One of the distinctive and original features of this station is the double receiver, the two receivers operating independently of each other so that either or both may be used. The act of raising one of them to the ear brings the transmitter into the proper position for talking and signals the switchboard. When released all parts return to their normal condition, making it impossible for any user to leave the telephone connected to the line. The receivers are of the watch case type, double pole, with metal cases, the coils being specially treated to make them waterproof. The transmitters are of the solid black type, the chamber being hermetically sealed, there being used nothing that will be affected by the moisture. The arm will support a weight of 200 pounds. The case which encloses the station is of composition, polished and oxidized and provided with a channel into which is fitted a moulded gasket of pure rubber.

The non-watertight stations (figure 1) are interchangeable with the watertight 'phones, the operative parts being mounted upon a mahogany base instead of a metallic case.

With each station there is furnished a separate watertight vibrating call bell. The design of the mechanism of this bell is distinctly special, the blow being delivered to the gong through a phosphor bronze diaphragm, which is reinforced so that there is no danger of its being worn through by use. The parts of the bell are made of non-oxidizable metal with the exception

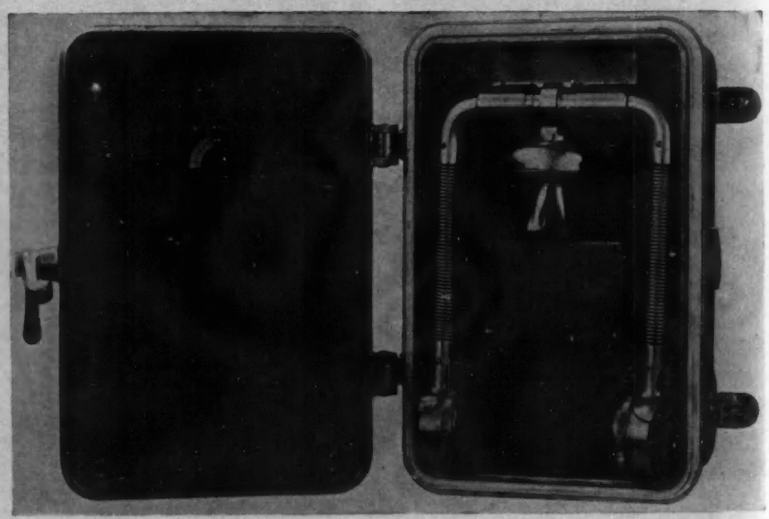


FIGURE 3

of the iron and steel parts, which are copper plated and lacquered to prevent corrosion.

The operative parts of the switchboard are mounted in a heavy brass case, shown in figure 3. This is gasketed so that when the cover is closed it is absolutely watertight. The case is divided into two compartments, the upper containing the terminals and the lower the switchboard proper. The upper part of the case is drilled for 2-inch conduits. The terminals

are of heavy copper lugs and are insulated with mica. A distinguishing feature of the board is that the connections are made without cords, there being used specially designed keys instead. The front of the switchboard is sub-divided into vertical strips, each holding four keyes. By taking out two screws any one of these strips may be removed, exposing for examination every contact and connection on the strip. The whole front which supports the case and signals is hinged at the bottom, so that it may be readily let down, allowing the cables to be examined. A supervisory signal is provided with each connecting circuit, the purpose of which is to indicate when the conversation has been finished.

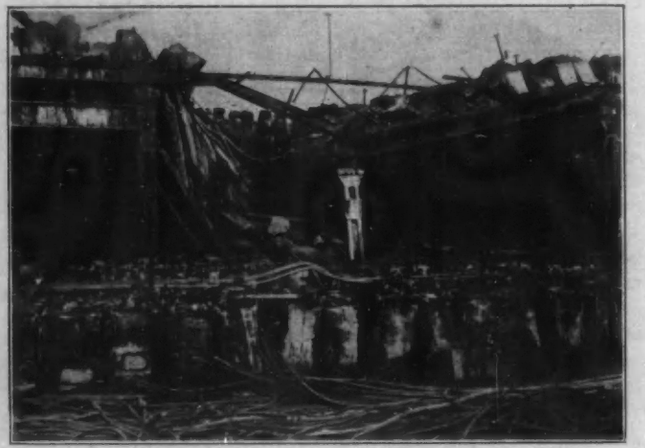
Provision is made for connection with shore exchanges, the signaling current being obtained from a hand power generator which is held in the box shown at the right of the cut. The system will work in connection with either a common battery or a magneto exchange.

Current for the transmitters is taken from a Holtzer-Cabot motor generator of the noiseless type. These circuits draw their current directly from the motor generator, there being no storage batteries. The ringing current is obtained from the ship's ringing dynamotor, or in case of disability, from an emergency set of dry batteries. The system operates on a three-wire circuit and five conversations can take place at the same time, or any number of stations can be connected and an order transmitted simultaneously to them from any other station.

The system as a whole has been built with a special view to ruggedness so that nothing short of actual violence can cause injury.

STORAGE BATTERIES IN THE SAN FRANCISCO FIRE.

The San Francisco Gas & Electric Company's Stevenson-Street plant was situated within the fire zone of the fire following the earthquake of April 18th, 1906. In this plant were installed engines, generators, transforming apparatus, and in a separate room three storage batteries. Two of the storage batteries were installed on the ground floor and one on the floor above.



STORAGE BATTERY ROOM AFTER THE FIRE

The illustration shows the condition in the battery room shortly after the fire. In the foreground are a number of lead covered cables in process of re-installation. Back of these stand the rows of cells on the ground floor, partially covered in the center by debris from a section of the second floor which had fallen in. Each cell consisted of lead plates immersed in dilute sulphuric acid contained in a lead-lined wooden tank. Owing to the intense heat, the wooden tanks were completely burned away, but the circulation of the acid which remained at a comparatively low temperature prevented the lead linings from melting, thus protecting the vital part of the battery (the plates). The lead connecting lugs of the plates projecting above the acid were melted, and most of the copper bar connectors dropped down on top of the cells, but a large proportion of the plates on the ground floor were uninjured, and are now being re-installed by the Electric Storage Battery Co.

A larger proportion of the plates on the second floor were destroyed, on account of the floor having fallen in, thereby bursting the lead linings, which allowed the plates to be exposed to the heat.

The San Francisco Gas & Electric Co. also had three sub-station batteries located at different points in the burned region. These batteries were completely covered by fallen walls, and it was at first supposed that the batteries were destroyed, but upon investigation a large number of plates were found to be uninjured, having been protected in the same manner as described above.

A NEW CONCERN DEALING IN POWER PLANT EQUIPMENT.

L. D. Armstrong and Wm. M. Kreling have returned to San Francisco after securing a fine line of agencies for the newly organized Armstrong-Kreling Machinery Co., with temporary offices at 2815 Washington Street, San Francisco. They expect to be in the down-town machinery center within the next week. As dealers in high grade power plant equipment they will handle the following machinery, of which we append a brief description:

The ROLLINS ENGINE, of 29 Mason Street, Nashua, N. H., is a high grade, heavy duty, automatic, four-valve engine noted for its efficiency, durability and perfect regulation. They represent in design advanced ideas of modern engineering, and, in construction, the best results attainable from carefully selected and skillfully handled materials.

The ERIECO ENGINE, of Erie, Pa., is a modern designed high speed automatic engine, equipped with the Ribblet automatic governor, assuring close regulation.

The OSWEGO-McNAULL WATER TUBE BOILER, of Oswego, N. Y., is a flange steel sectional header water tube boiler. Each header consists of a flat tube-sheet and a flat hand-hole sheet, not flanged, but riveted to an extra heavy wrapper of channel form; sheets stayed with hollow stay-bolts 1¼ inches in diameter, spaced with 6-inch centers. The method of obviating flanging is peculiar to the Oswego boiler, and is fully covered by patents.

The EPPING-CARPENTER, of Pittsburg, STEAM PUMPS AND CONDENSERS, built for all services, the pumps being equipped with balanced piston valves and lost motion adjustment. They embody the latest and best designs approved by modern engineering practice.

The GOLDEN-ANDERSON VALVE SPECIALTIES include clean-seat globe and angle valves, which cleans its own "seat and disc"; cushioned non-return valves for boiler protection; patent float valves for railway standpipe service; roller lock railway blowoff valves and altitude valves especially adapted for buildings.

The MARINE ENGINE AND MACHINE COMPANY'S Groshon high duty compound crank and fly wheel pumping engine, especially adapted where large quantities of water are to be handled where the best efficiency is required.

The BURKE ELECTRIC CO., of Erie, Pa., belted and direct connected three-wire D. C. generators, embodying new features in this type of machine and variable speed induction motors for two and three phase.

NEWS NOTES

ELECTRIC RAILWAYS.

Portland, Ore.—The Portland Railway, Light and Power Company will extend and improve their system.

Calgary, Alta.—A by-law to raise $250,000 was endorsed by the rate-payers for the purpose of constructing a municipal street railway.

Walla Walla, Wash.—The Walla Walla Valley Traction Company will soon commence construction work on the proposed extension to Wallula.

Seattle, Wash.—Two more cars have arrived for Fred E. Sanders' road and will be put on the run between Ballard and Lake McAleer. Grading between McAleer and Hall's Lake has been completed and track laying will be commenced at once.

Spokane and Inland Empire Electric Railway Company —Work has been started on a depot at Hayden Lake, where a structure of Swiss chalet style will be erected. It will have a waiting room 30 by 30 feet, an office 12 by 12 feet and a baggage room 14 by 20 feet. It will cost $20,000. D. A. Miller has been named agent.

Inter-Valley Traction Company—Work has been begun on the first line in the Yakima Valley of Spokane. The line will be two miles in length, and its completion will mark the first link in the chain of suburban lines which will radiate from North Yakima. President H. B. Doudden announces that the directors had decided to begin work with a small force, but the crew will be enlarged from time to time until a large force is at work in many places.

Spokane and Big Bend Electric Railway—Col. W. H. Plummer of Spokane was elected president of the company, the secretary being Thomas Hye, at a special meeting of the stockholders representing 90 per cent of the capital of the concern. The directors are: F. B. Gregg, S. J. Hollans, Solmon Mayer, D. R. Cameron and the officers named. By unanimous vote the stockholders indorsed all of the contracts entered into by the president or the board of directors, and all the proceedings, on behalf of the company, which has been carried out and performed by the old officers. The company has begun work on a line into the Big Bend wheat belt, west of Spokane, having connections into Spokane over the Spokane and Inland Empire Electric Railway.

F. O. Adams of Chicago, president of the Spokane Western Power and Traction Company, and Mrs. D. W. Iden of New York, were married at the parsonage of Westminster Congregational church a few days ago. Rev. Dr. A. E. House, pastor, read the service. Mr. Adams came to Spokane from Chicago last September to take charge of the Spokane, Western Power and Traction Company, which will construct a line over the Spokane smelter right of way to the northwest. During the time that he has been in Spokane he has made many friends among the business men of the city. Mr. and Mrs. Adams will make their home in Spokane.

The Columbia and Walla Walla Traction Company—Former Governor Miles C. Moore, president, gave out the following statement in Spokane a few days ago: "While we are not out with brass bands announcing our intentions, we have been quietly at work getting everything in proper shape for the financing of the project, after which we will be all ready to begin active construction work on the Farmers' electric line, which will give the farmers of Walla Walla and Columbia counties a direct line to the seaboard and the benefit of low water competition on grain and all other farm products. This line has been all surveyed and practically all of the right of way secured for the entire distance, and I am in touch with syndicates in the east who will be glad to finance the project, or furnish what money we will need over and above the stock that will be taken by local capitalists, who propose to retain a controlling interest in the road. The statement to the effect that we may abandon the road is, therefore, to say the least, premature."

Spokane, Wash.—Forty million dollars will be expended by eastern capitalists in the building and equipment of 1000 miles of electric lines in eastern, central and western Washington, the company planning also to supply towns between Spokane and Tacoma with water, light and power. The foregoing announcement is made by P. P. Carroll of Seattle, representing the syndicate, which, he says, has begun work on three lines. This plan includes the completion of the proposed Puyallup Valley Northern Rapid Transit Railway at a cost of $2,500,000, also the completion of the Snohomish Valley Railroad, upon which construction work has started. This line will cost $3,000,000. A third line is the Seattle, Chelan and Spokane Railway. A company was recently chartered for the purpose of constructing this electric line. The cost is placed at $7,500,000. The Puyallup Valley Northern Rapid Transit Company has been incorporated nearly two years. Fred Chamberlain of Puyallup is its president, and John Mills is a prominent promoter of the line. A few months ago the incorporators of this railway closed a deal with an eastern firm of contractors whereby their electric line will be built in exchange for $2,500,000 worth of stock in the enterprise. Under the present plan it is understood that when these independent lines are consolidated this $2,500,000 in stock will be transferred to the consolidated company and a like amount of the big concern's stock issued to the railway builders. The Puyallup Valley line will extend from Tacoma to Puyallup, Sumner, Renton and other towns. It will traverse the valley between Tacoma and Renton, but will be constructed along the foothills, on an elevation high enough to remove the line from the flood district. The line conects at Renton with the Snohomish Valley Railroad, which line runs through Cherry Valley to Snohomish and north to Bellingham. The line passes through Monroe. It is being built by the same interests who have taken charge of the construction of the Puyallup Valley Railway, and construction work on the line is now in progress.

From the Sound, through Renton and east to Spokane, the Seattle, Chelan and Spokane Railway will be constructed. The application for a charter for this line was filed a few weeks ago. This is a sister proposition to the Puyallup and Snohomish Valley railways.

The men who are backing these enterprises have decided they can build and profitably operate the lines in connection with numerous power plants to be operated by water power. The plants will be located at towns along the lines of railway, and will furnish power for commercial and municipal uses as well as for the operation of the lines of railway. The richest agricultural sections in Washington will be penetrated by these railways, together with great tracts which have been valueless until recently, but which are now being rapidly populated because of government irrigation development.

TRANSPORTATION.

Guadalajara, Mex.—Carlos M. de Landero, manager of the Bank of Hidalgo, has concessions to use the water of the Tuxpan River. He will organize a company and build a power plant.

Los Angeles, Cal.—An ordinance has been adopted by the Council, giving J. Harvey McCarthy a franchise to construct and operate an electric railroad upon a portion of Indiana Avenue.

Chihuahua, Mex.—According to report from Parral, McQuatters & Truehart, the contractors, will start work grading for the electric street-car lines in that city within sixty days.

Grass Valley, Cal.—Surveyor W. W. Waggoner and a crew of six men are engaged in running the line for a ditch from near North San Juan to a point below the Delhi mine. The ditch will be about ten miles long and will take water from the Middle Yuba River. It is not known for what purpose the water is intended, but there is a rumor that a new power company is arranging to put in a plant.

Los Angeles, Cal.—Back of the trip of the Board of Public Works and the city engineer to Griffith Park recently is thought to be a strong desire on the part of the Los Angeles-Pacific Railroad to gain entrance to the park. The company desires a franchise for a road, one mile in length, within the boundaries of the park, it is said, and it is believed that the proposed road would be very popular.

Oakland, Cal.—The Oakland Traction Consolidated has filed an application for a street railroad franchise extending from Perry Street and Pleasant Valley Avenue over Lake Shore Avenue, Lake Park Avenue, and Lake Avenue to Grand Avenue, where it will connect with the present Grand Avenue line. The purpose of the proposed line is to open a new section of Piedmont to street railway traffic. The ordinance is in the hands of the Street Railroad Committee.

Napa, Cal.—The report is confirmed that Henry Brown, who was granted a franchise two weeks ago by the Board of Supervisors to operate and maintain power lines over the county, is representing a number of San Francisco capitalists in the matter and that a company will be formed to compete with the Bay Counties Power Company. The Great Western Power Company may be behind the deal, and will prove a strong competitor if this is the case. The fact that the lines extend to the extreme northern border of Napa County encourages the belief that Cache Creek will be the source of power.

Napa, Cal.—Manager L. J. Perry, of the Napa Valley Electric Railway Company, has set at rest the stories which have been going around that the new Napa and Lakeport Railroad, which is incorporated to build a line from Lakeport through Napa to Tiburon, has purchased the local road. Manager Perry said that overtures for the purchase of the road and the Monticello Steamship Company, running from Vallejo to San Francisco, have been made, but neither the road nor the steamers are on the market. The work of completing the extension of the electric road from this city to St. Helena is being hurried along and service is promised by August 1. The new cars will arrive early in June.

Eureka, Cal.—Superintendent M. M. Martin of the Humboldt Transit Company has received word from George Hazleton of San Francisco that about two miles of rails have been purchased for the extension out Myrtle Avenue and Broadway in this city. The expectation is to have the Myrtle Avenue division ready for operation in thirty days. Just when the Broadway line will be completed is not certain. Linemen will be put to work on Broadway when the Myrtle Avenue extension is well under way, the supply of overhead material being so small that nothing will be done on any other section of the road until it is sure that enough is on hand for the east end. Two new cars are expected by the latter part of May.

Santa Rosa, Cal.—An application for a franchise to distribute electric current for lighting, heating and commercial uses all over Sonoma County was presented to the Board of Supervisors last week by Cashier Frank M. Burris of the Santa Rosa Bank. While it is not stated, it is believed that the Eel River Power Company, which has for years been developing a plant in Mendocino County, is behind the project. The application states that the wires will be strung from the Mendocino County line through Cloverdale, Geyserville, Healdsburg, Lyttons, Windsor, and Fulton to Santa Rosa; from this city west through Cloverdale, Glen Ellen and Sonoma to the Napa County line, and from this city south through all the towns to Petaluma, and thence to the Marin County line.

Oakland, Cal.—By September the Alameda Mole train system running trains to Oakland and Alameda will be operated by electricity. Two ferryboats will be built and put on the run in order to give a twenty-minute service to the Alameda Mole. Fifty large electric cars are now being built in St. Louis. As soon as these changes are made the work of converting the Oakland Mole ferry system into electric lines will be begun. General Manager E. E. Calvin of the Southern Pacific Company has announced the changes the company contemplates. He has ordered built the fifty cars of more than usual length and seating capacity, which will be run in trains on the eleven or twelve miles of ferry lines running to the Alameda Mole. Plans for the two new ferryboats have been drawn, and the contracts are to be let within the next week or two. "These two ferryboats," says Manager Calvin, "will be built after the design of the Berkeley, but will be much faster. It takes three boats to maintain the present twenty-minute service to the Oakland Mole. We have now a thirty-minute service in connection with the Alameda Mole. The two new boats will move fast enough to give the Alameda Mole a twenty-minute service. The fifty standard electric cars just ordered will have double platforms and exits and they can be emptied of eighty to one hundred passengers in a minute and a half. The company will have its own power house to generate power to operate the Alameda Mole system. The same power station will also supply electric power for the Oakland Mole system. The Alameda mole electric line to Oakland will run as far as Fourteenth and Franklin streets, while the one through the city of Alameda will run just beyond the Park Street station. In connecting the Oakland Mole lines to Berkeley, Alameda and Oakland, we will preserve the system as it now exists, the Oakland line going through to Melrose."

WATERWORKS.

Sonora, Cal.—At the recent meeting of the Board of Trustees a petition was presented by the Union Construction Co. for the privilege of laying pipes in the streets for water supply. The matter was laid over.

Oakland, Cal.—Inability to purchase at a reasonable figure a site for the pumping plant for the auxiliary salt water pipe system has caused delay in forwarding plans for the installation of the plant. In the past tax levy budget, $27,000 was provided, but the money is not available owing to the extraordinary expenditures which were forced upon the city government as a result of the big fire. City Engineer Turner said that $15,000 had been demanded for a site that seemed suitable, and that the Board of Public Works considered the amount too large.

TELEPHONES.

Albany, Ore.—The Home Tel. Co. is to place some of its wires under ground.

Monida, Mont.—The Centennial Tel. Co. has been organized to build a line to Lakeview.

Vancouver, Wash.—The East Mill Plain Tel. Co. has decided to extend and enlarge its service.

North Yakima, Wash.—The County Commissioners have granted a franchise to the Cowichee Tel. Co.

Anaconda, Mont.—The installation of the new telephones of the Rocky Mountain Bell Co. is now in progress.

Dayton, Wash.—The Smith Hollow Tel. Co. has about completed its line, as has also the Delaney Company.

Olympia Wash.—Telephones will be installed in every room at the Hotel Kneeland. J. E. Goldsmith, manager.

Moyie, B. C.—The new switchboard for the local telephone exchange has arrived, and will be installed at once.

Victoria, B. C.—Large extensions are being planned for the local office of the B. C. Tel. Co. R. B. McMicking, manager.

Joliet, Mont.—The Bell Tel. Co. has leased the upper floors of the Meyer Block, and are fitting it up as their central office.

Echo, Ore.—The Butter Creek Tel. Co. has installed 'phones in the main offices of the reclamation service, along the East Umatilla project.

Maple Falls, Wash.—The Maple Falls Tel Co. has completed the construction of its line to Bellingham, where it will connect with the Sunset.

Olympia, Wash.—The Brighton Park Tel. Co. has been organized by E. Munn, Harry Drewery, Ed. Drewery, Hugh Williams, A. G. West, Ben Shinke, E. Elliott, George Irwin and Fred Lewis.

Bellingham, Wash.—The Home Tel. Co. is rapidly completing the installation of its system here. Six crews are now stringing the drop wires to the houses of the patrons. J. B. Middleton states the system will begin operating about June 1st.

Seattle, Wash.—The Independent Tel. Co. has completed the construction of its new long distance lines between here and Tacoma. The long distance line building from Seattle to British Columbia is completed as far north as Edmonds. Work on the extension of the local system to South Park will be completed in two weeks.

Sacramento, Cal.—Work has ceased on the improvements planned by the Sunset Telephone Company in Placer, Butte, Colusa, Nevada, and other counties of Northern California, and the company has discovered that the reconstruction means an immense outlay of capital. In the three weeks that the company has been doing no outside work there has accumulated the sum of $870,000. It is estimated that the company will save nearly $1,000,000 a month by the cessation of its outside operations.

Spokane, Wash.—Another independent telephone company has been organized in the Grangeville district in Idaho, southeast of Spokane. The line will be operated on Comas prairie at Red Rock precinct and from Dryden postoffice to the reservation line. The commissioners have granted a franchise for the use of highways. The company's officers are: T. A. Hughes, president; H. J. Gormen, vice-president; T. Robison, treasurer; F. W. Davis, secretary; M. R. Rogers, manager, and J. A. Johnson, E. Dunn and Ben Robison, building committee.

Spokane, Wash.—E. E. Crandall, manager, and John Weber, electrician of the Interstate Co-operative Telephone Company, at Kendrick, Idaho, southeast of Spokane, are installing the new large switchboard and connecting the American Ridge, Little Bear Ridge, Big Bear Ridge, Bed Rock Canyon, Cameron and Leland farmers' line in the central office here. This gives all the surrounding farmers telephone connection with Kendrick and through Kendrick with all the northwest territory. The Pacific States Telephone Company has for some time been making efforts to get the farmer lines to connect with them, but after many meetings they have decided to cast their lot with the Co-operative Company.

Spokane, Wash.—Active operations on the farmers' telephone lines into Gifford, Idaho, southeast of Spokane, are under way and are expected to be completed in a short time. The lines are being put up in a substantial way. Thirty-foot red fir poles are being put up on the main line from Summit to a mile beyond Gifford. Another line runs to Rigger's sawmill, four miles east of Gifford, and another across Jackson's Canyon via Summit. The switchboards, now at Lookout, will probably be moved to Gifford.

Spokane, Wash.—Farmers living along Wilson Creek and in the south Hollow district near Dayton, Wash., are making arrangements for the construction of a rural telephone system, from that portion of the country, and another will be built from the Tucannon district, 18 miles in length and will require with the double wire system 40 miles of copper. Both lines have arranged to connect with the Pacific States system at Dayton.

Spokane, Wash.—Announcement is made that the Home Telephone Company will begin construction work on its $60,000 building at Second avenue and Howard street in a short time, and it is expected to have the structure in readiness for the installation of apparatus late next fall or some time during the winter. Plans, prepared by Albert Held of Spokane, show a main building 71 feet on Howard street, 100 feet deep, two stories high with full basement. The material will be light brick and steel reinforced concrete. The partitions will be of hollow tile and the exterior trimmings of terra cotta. Light for the second story will be by means of specially constructed roof lights. The apparatus will have a capacity for 10,000 connections. The first floor will contain the business offices, while the automatic switchboard will be on the second floor, where will also be the storage battery and machinery rooms. Electric motor and gas engines will be installed to insure perfect service. The wires in the business section have been put under ground, while those in the resident districts are to be strung on poles, 3000 of which are awaiting erection. The company has also received other material and machinery at its warehouse in Division street.

REMOVAL NOTICE.

Barton, Squires, Byrne, Inc., dealers in hose, packing, leather and rubber belting, have removed from 27 Commercial Street to 533 Howard Street, San Francisco, California.